METALS and ALLOYS

The Engineering Magazine of the Metal Industries

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PATTERSON MILLS *and* PATTERSON BLENDERS

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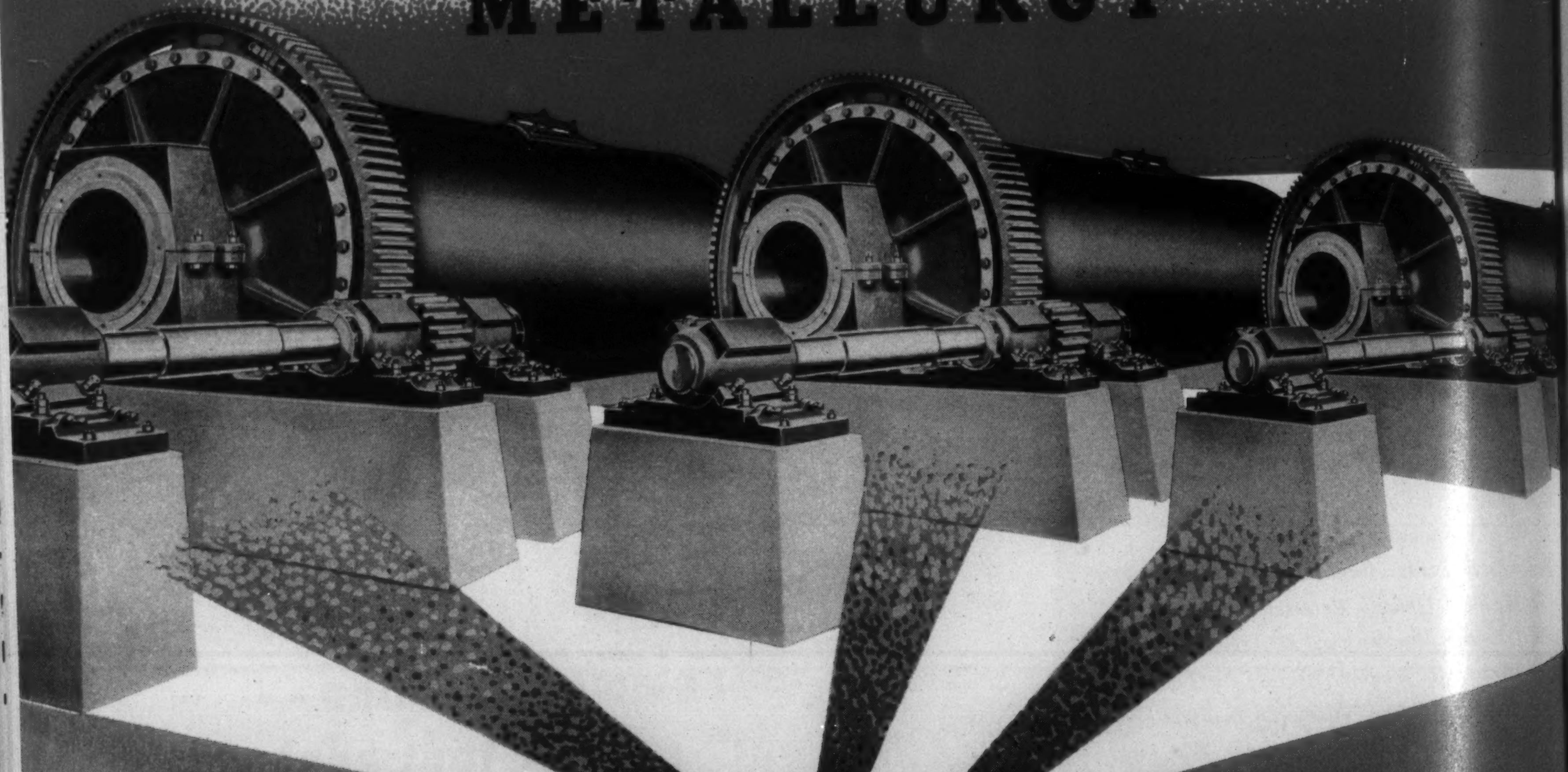
POWDER METALLURGY



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Richard L. Ca

The PATTERSON FOUNDRY
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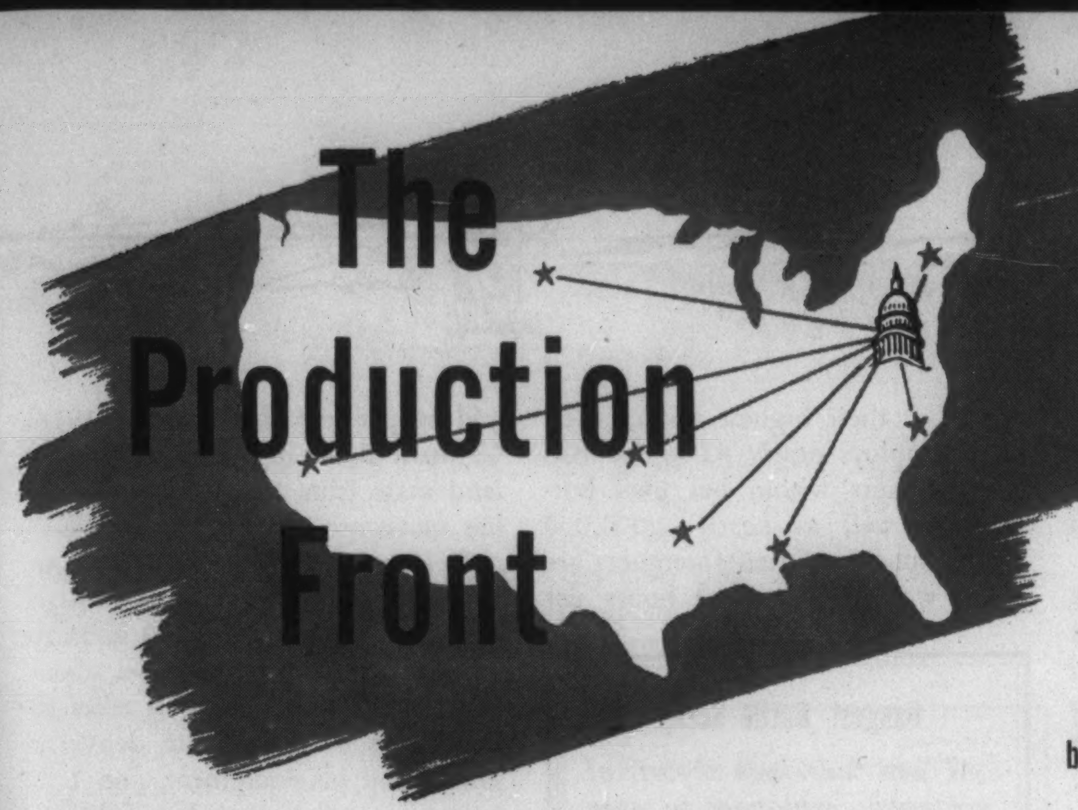
The Production Front



by Harold A. Knight
News Editor

Average war producer zig-zags forward — he converts from peace to war — from one war item to another — switches back to peace, etc. . . . Cut-backs are often followed by come-backs. . . . Essential civilians, such as railroads, get more steel.

Production shortage of first half must be compensated. . . . Production per man-hour basis less than pre-Pearl Harbor. . . . "Bigger they come, harder they fall" to apply to Germany. . . . 400 troop and 730 cargo ships to transport 1,000,000 infantry soldiers.

One hundred to 700 per cent improvement over World War I. . . . We hear more of siege guns. . . . Our arsenal plant and equipment program 80 per cent completed. . . . No civilian auto output in 1944. . . . We will have an inventory and pool of machine tools.

Our poet laureate and cartoonist philosophizes on war complacency. . . . Metallurgy of the needle and fishing line. . . . How come magnesium? . . . We stepped on a trade name's toes. . . . Engineers tell us the airsickness colors. . . . The hand that shook the President's. . . . Nature's laws. . . . Mud houses.

Industry Is Like a Convoy

The convoy crossing the broad expanse of water zig-zags, changes direction, alters pace and goes through motions generally resembling a ball room dancer or ball carrier in an open field on the football gridiron.

So, hectically, has the average industrialist been forced to progress. First it was conversion from peace to war goods, then from one type of war goods to another as strategy in the military field changed; then perhaps partly back to original peace lines. Like a quick-change artist of the stage, he has appeared one moment as a romantic gypsy and a few minutes later as Little Bo-Peep. Unfortunately for him, such uncertainties and rapid shiftings may continue for many months to come.

An example of this changing of products to be manufactured is illustrated when late in July WPB gave permission to produce 10 sorely-missed household articles, such as metal pot scourers, flour sieves, carpet sweepers, baking pans, food choppers, etc.

Cut-Backs and Come-Backs

More upsetting perhaps have been the ordnance orders cut-backs caused by changed strategy in World War theaters. The vulnerability of the tank and the ascendancy of amphibious warfare is a case in point.

However, in many cases of cut-backs, alternate ordnance contracts have been awarded. Last November R. Hoe & Co., New York, worked on a $12,000,000 contract to make 90-mm. recoil mechanisms, 500 per month. Oversupply brought a cut to 240 monthly. This was compensated for by awarding over $10,000,000 in contracts for badly needed plane parts, engines and Navy gun mounts. R. Hoe & Co. again works at full capacity.

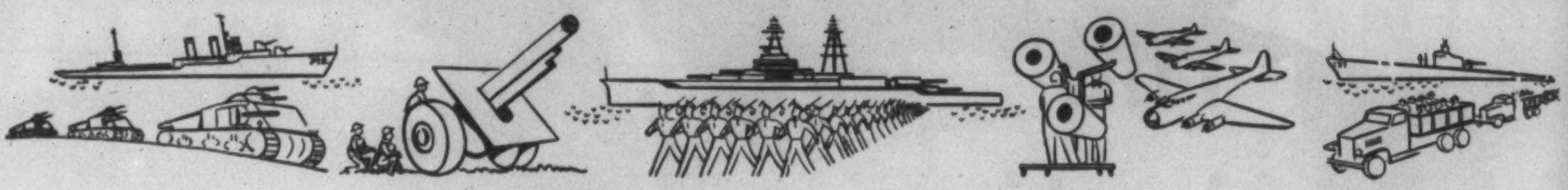
Dictaphone Co., Bridgeport, Conn., received a sharp cut-back on remote control systems for guns, but soon became so busy making telescope mountings and doing sub-contracting that it threw up its hands against further orders.

Koppers, Inc., Baltimore, found an "out" in maritime engines, with capacity tied up until late 1944. Bridgewater Mfg. Co. lost $1,300,000 in contracts, only to regain $1,212,822 worth of contracts for struts for big army transport planes.

Essential Civilian Enterprises

It is encouraging that we are finding the excess materials to manufacture goods for essential civilian needs, lest our economy break down, as it already has in some countries such as Italy. It was announced in mid-August that provision had been made for the construction of an additional 5,801 new freight cars in 1943 out of steel allocated to the railroad industry for the third quarter, meaning a total of 32,000 new freight cars built in 1943.

Yet our war production is by no means what it should be. During the first half of the year only two-fifths of our total scheduled 1943 production had been accomplished, according to Lt.-Gen. B. B. Somervell, chief of the Army Service Forces. He blamed the lag on in-



creasing rate of labor turnover, design changes coming through as the result of battle experiences, and an absenteeism rate that is higher than it should be.

Doubtless many of our readers will place the major blame for this disappointing production upon Washington itself, the reasons being all-too-well-known: New Dealers in the saddle instead of industrialists; too much toadying to labor, culminating in the disgraceful coal strike; too much passing of the buck when important decisions were to be made; too many questionnaires and blanks to fill out. But why go on?

We Make an Interesting Survey

Undoubtedly, too, decreasing efficiency of labor, as skilled men were drafted, was an important factor. This is the predominant consensus in a post-war survey that METALS AND ALLOYS is conducting among presidents of industrial companies for its October issue with 23 salient questions asked.

As this is being written, about 60 replies have been received. Question 13 is: "Can you estimate how much more efficient (on a production per man-hour basis) your operations are than on Dec. 7, 1941?". The question was unfortunately worded, being biased on the side of a positive answer. But notwithstanding, the majority of the first 60 told of less efficiency because of so many green hands.

We believe that the earnestness of war plant workers outweighs the devil-may-care attitude of the nouveau riche and the desire to take days off to spend the jingle jangle in their pockets. Too many sons, brothers and fathers are in the service to produce willful inefficiency. Lessened efficiency is weakness of the flesh, rather than of spirit.

It Will Be a Giant Who Falls

Let us not forget that our foes are still strong. Germany alone has 10,000,000 men in her armed forces and more than 1,000,000 auxiliaries doing military work. Of the 350,000,000 people in Axis Europe, between 150 and 175 million are employed at their highest skills. Germany employs nearly 6,000,000 foreign workers within her own borders, as well as nearly 2,000,000 war prisoners. Often foreigners are being worked 70 to 80 hours per week. Children start work in Germany at 14 to 16; in the rest of Europe, 12 to 14.

Danger! Battle Scrap!

There have been reports of mysterious explosions in open hearth furnaces and cupolas where scrap had been charged. Rumors have it that some of the scrap came from battlefields and that unexploded shells embedded in the scrap had caused the explosions. Army officials have denied this attributed cause for explosions, claiming that demolition squads of the Army are well trained in making harmless all battle refuse.

However, it is well for all concerned to be on guard. Larger and larger quantities of ferrous and non-ferrous scrap will return from shooting arenas. Danger in battlescrap is not new. For several years after the first World War scrap salvagers were wounded or killed in handling war scrap.

A common source of disaster were metal pipes from smokeless powder plants. Here gun cotton collected in elbows and turns, only to be forgotten. One day a metal-cutting power saw would be cutting up this "heavy melting steel" to charging box size. For several workers, this would be the "most unkindest cut of all."

We need the scrap. It must be used. But — caution!

Germany has powerful economic resources, industries are centralized; her technical development is far advanced; food supply is sufficient, and 50 per cent above that of 1918. Germany fights in a solid contiguous land mass from the inside—the Allies move around the rim.

It is necessary for the Allies to have 400 troop ships and 750 cargo ships to transport 1,000,000 infantry soldiers overseas. We have about 2,500,000 overseas now. It takes 10 to 18 tons of shipping to deliver a soldier and his equipment, and 1 to 3 tons a month to keep him fighting.

One infantry division expends 542 tons of ammunition in one day's firing; over 600 tons for an armored division. In one hour a 105-mm. cannon can shoot over 3 tons of steel. And thus could we go on about food and gasoline.

But we'll make the grade if the United Nations stick together. We've done many wonders. As a measure of progress, for instance, since World War I, our Ordnance experts have increased the range of anti-aircraft artillery 100 per cent, individual firepower 250 per cent, the size of bombs 300 per cent, and the speed of tanks 700 per cent.

Latest Style Note—Siege Guns

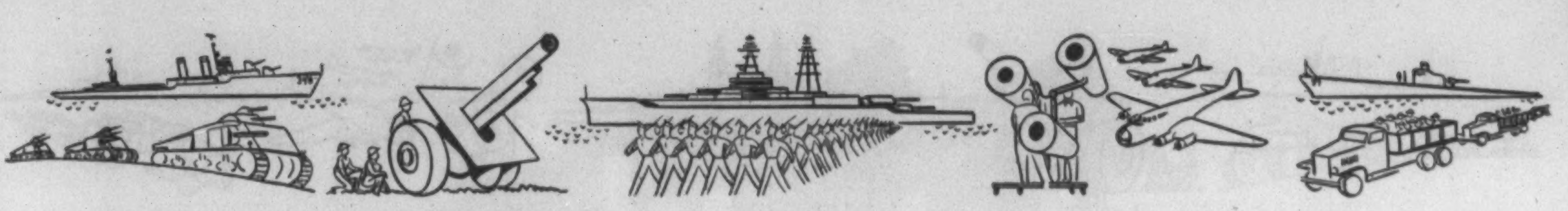
Our new 155-mm. gun with which we started firing onto the Italian mainland from Sicily is the most popular long-range, heavy-hitting bombardment and siege gun of the Army. On pneumatic tires, it can travel anywhere a truck can go, weighs about 15 tons and hurls a 95-lb. projectile over 15 miles. Siege guns may come into the limelight against Fortress Europe.

The 8-in. howitzer and 240-mm. howitzer are the largest mobile field pieces used by the Army. The former can fire a 200-lb. shell through a plunging trajectory 11 miles. We hope one doesn't strike Hitler—that would be too kindly an end for him.

"Arsenal of Democracy"

By mid-year, the Government's gigantic arsenal for the United Nations was more than four-fifths completed. Highlights:

Total of $12,038,000,000 of the $14,582,000,000 plant and equipment program was finished.



Ammunition and explosives, 95 per cent completed;

Synthetic rubber facilities, 61 per cent completed, as against 15 per cent on Jan. 1 and 3 per cent a year ago.

The 100-octane gasoline program, 39 per cent completed, as compared with less than 1 per cent at the beginning of the year. Private industry's share of the program is 63 per cent completed.

Iron and steel expansion, 75 per cent completed; and

Chemical facilities program, 90 per cent finished.

Completion of the entire 14½ billion dollar program will release quantities of critical materials for munitions and essential civilian manufacture. WPB executives believe that supplemental facilities programs will be relatively small.

No Civilian Autos in 1944

Barring a sudden cessation of hostilities, there will be no civilian automobile manufacture in 1944 because of continued shortages of materials and labor, WPB officials state. False hopes were raised, perhaps, when the Army ordered a 50 per cent cut on certain worsted and woolen products for the services, that saving immediately having been released for civilian use. Automobiles, however, contain too many critical materials.

The 16 Claimant Agencies asked for 13 per cent in excess of available supplies for the fourth quarter, an improvement, notwithstanding, from the 25 per cent excess requested for the third quarter. Original fourth-quarter requests for carbon steels, one of the most critical, were finally pared down 9 per cent for the Army, Navy, Aircraft Resources Control Office of WPB and Maritime Commission by the Requirements Committee of WPB. The other 12 claimants had their requests cut 17 per cent.

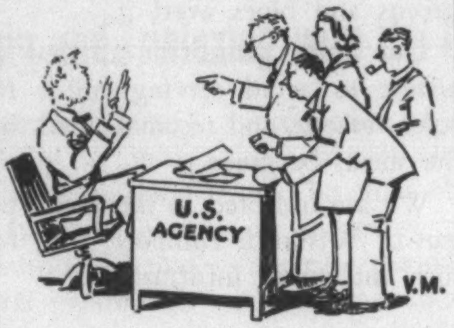
All 16 agencies were finally granted 15,500,000 tons for the fourth quarter.

Machine Tool Inventory and Pool

Machine tool authorities seem agreed that if all machine tools in the U. S. were being used as maximum we would have far more metal-working machinery than is needed. Only a few specialized equipment items would need to be added to the present supply.

The Metal Workers Answer Back

by V. M. McConnell



The big wig sat him at his desk
And wept into his beard.
Said he, "Ah me, these victories
Are what I mostly feared.
The danger is the workers may
Become unduly cheered."
"Unduly cheered, my eye, old top,
This war is everyone's."
Replied the men and women
Making tanks and planes and guns,
"We simply cannot let up now,
And run out on our sons."

The Tool Div., WPB, is working on the following plan:

(1) Take an inventory, in terms of use or idleness, of all the following types of machine tools valued at $500 or more, and manufactured since Dec. 31, 1939:

(a) metal-forming and bending tools, including presses, forges, extrusion, rolling, etc., equipment;

(b) metal-cutting tools, including drilling machines, millers, lathes, broaches, shapers, profilers, punches, saws, and the like;

(c) welding equipment of all kinds.

(2) Keep this inventory up-to-date by requiring prompt reports of any change in use or status.

(3) Make available to industry a pool of idle equipment.

By-products of this huge undertaking, according to WPB officials, would be:

(1) Increasing the amount of sub-contracting through making more tools available.

(2) Concentration of attention upon certain lines of genuine tool shortages.

Pointed Metallurgical Observations

Metallurgy enters into little things—the trivia of life—as well as airplanes, dynamos and battleships. Thus Sam Tour tells a tale about needles.

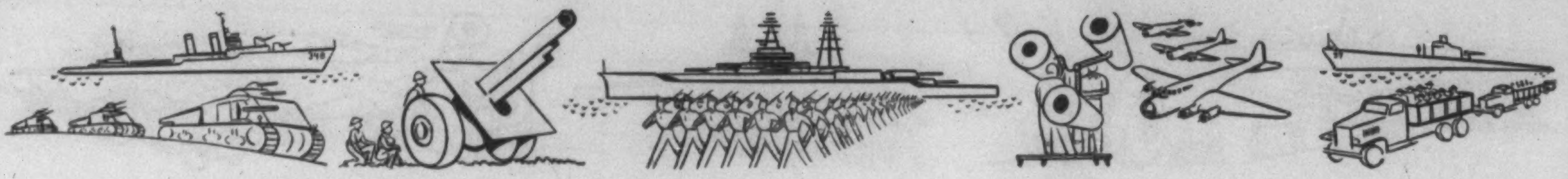
A large manufacturer of war goods recently sent samples of needles to Tour's metallurgical laboratories in New York for analysis. Some needles were coming through that couldn't take it—they corroded, broke and damaged material in manufacture.

Spark tests, stiffness tests and photo-micrographs were taken and disclosed that improper heat treating had failed to put the carbides into solution, resulting in a brittle product that snapped easily. Also, a plating treatment was found desirable, preventing corrosion and giving a smooth-working surface that reduced friction and gave the desired penetration to the cloth.

Trivia No. 2 concerns stainless steel fishing lines for the derelict human on the life raft at sea. Emergency fishing kits are required these days on all lifeboats and rafts of U. S. merchant ships.

Each kit is packed in a hermetically sealed can; it must contain seven fishing rigs of assorted sizes and dehydrated bait, cotton gloves and a non-sinkable knife. Maritime officials have specified that the various sized O'Shaughnessy hooks be attached to stainless steel wire.

Will the sportsman of post-war insist on the same?



That's How Magnesium Was Born

Magnesium extracted in Michigan comes from a fossil sea that lies under that state. In past ages a bowl-shaped basement structure was formed under the central part of Michigan, which was submerged beneath the sea. Centuries later the contour of the land changed, when this inland sea was cut off from its connections with the ocean, leaving a great bowl full of sea water. Gradually this evaporated and deposited pure salt around the edges of the bowl at places like St. Clair and Port Huron.

In time the bowl began to fill up with clay and sand and other materials washed in from the sides. Finally, the bowl was filled with various strata of brine-bearing rocks and covered over with an impervious cap of rock and clay. The brine is 3.5 per cent magnesium chloride, 11.5 per cent common salt and 10 per cent calcium chloride, not to mention bromine. There are also oil and gas in other of the rock strata.

The brine at Midland is produced from wells similar to oil wells and pumped through pipe lines to the central plant.

Such was a recent explanation of Leland I. Doan, vice president of the Dow Chemical Co.

Nix on Rex

In our May issue we orated enthusiastically on stainless steel; how it is so versatile that it deserves a better name—a name perhaps *like* Rex metal.

A patent attorney wrote us and we read suggestions of alarm between the lines. He reminded us that the brand name of the manufacturer he represents, an item made solely of metals, is already "Rex".

However, we assured him that our campaign to glorify stainless steel by a loftier name had not gained momentum—gained momentum! It has not gone as far as a shrink fit part removed from the sub-zero refrigerator and in process of expansion!

Why Not Wear Green Glasses, Then?

One wonders how far engineers will eventually go in splitting hairs between the right and wrong way of doing things, and to what tenths of thousandths of an inch they'll regulate our every day conduct.

Color engineers have now studied mal de mer of the air, or airsickness to you and me, and say that it can be induced by certain colors. Browns and yellows cause nausea, while greens and blues avert it.

One color consultant advised an airline to avoid serving coffee for color reasons, and recommended that the sheets be green.

We are indebted to the house organ of Wishnick-Tumpeer, Inc., for such intriguing information.

The Hand that Shook the President's

Our publisher boss is much impressed by the fact that we, while in the line of duty, shook hands with our President in the White House. When introducing us to strangers, the boss points out our right hand and in a solemn, awestruck voice, confides that that hand shook hands with the President.

It all took place in the round office of the President, with three corridors radiating in from various ante rooms where nervous delegations were pacing up and down, awaiting their turn to pass down their particular corridor. On the wall are many maps and rare etchings, with ships predominating. Secret service men are lurking in every corridor entrance. We merely fingered a cigaret, but were whispered to sternly: "No smoking." We were a group of 50.

Franklin Delano Roosevelt is a born actor. His cigaret assembly—holder and tobacco—are tilted at the proverbial rakish angle. He screws up one corner of his mouth in the behind-the-footlights style of meditation. He looked a bit yellow in complexion—the strain, no doubt.

"A regular fellow," the boys said afterwards, perhaps forgetting politics for the moment.

Nations That Follow Nature's Laws

Why have food receptacles that one throws away — like tin cans? Why not eat the containers, as we already do with synthetic sausage casings and ice cream cones? So suggested Dr. Willard H. Dow, in his Chandler Medal Address at Columbia University.

The address was thoughtful, imaginative, philosophical and poetically expressed at many points. He mentioned two concepts of man throughout the ages towards the rainbow. Greedy man merely sought the pot of gold, which supposedly rested at the rainbow's end. The more patient man merely tried to learn lessons from the rainbow — he developed the spectroscope, for instance. The fool speaks of conquering nature; the wise man implores nature's aid. He concludes:

"A world at peace will be a world fundamentally based on nature's laws. Nature's way is simple, plain and direct, but we sometimes follow a devious path before we reach understanding. Those nations who follow nature's laws most closely are bound to become supreme — supreme in their modesty, supreme in their honesty, and humble before nature's altar. Again I ask you, consider the rainbow."

Here's Mud in Your Eye

We had thought by now that we had heard of all the substitutes and alternates for everything, and we were beginning to yawn. But we snapped to attention when we heard of the rammed earth building, "the cheapest and most ancient method of construction known to man," so old that it is new. It is one part stiff clay, one part sharp sand and two parts stone. The mixture is tamped into wall molds, layer on layer, using wooden or iron puddlers.

Rammed earth, also called "pisé de terre," produces a surface resembling the ancient adobe dwellings. A structure normally costing around $5,500 would cost $4,000 with "pisé de terre." Windows, door frames and supporting beams can be placed with comparative ease.

Duplexing and Triplexing with the Electric

The fundamental principles of duplexing or triplexing in the manufacture of steel are by no means new. There are many cases in American metallurgical engineering practice where hot metal from the blast furnace or cupola is either directly introduced into the open-hearth or blown in converters previous to its use as hot metal.

But the very great demand for electric steel, due to the war, has introduced new metallurgical techniques into the industry which may have far-reaching effects. Quite recently several large electric furnace plants have installed duplexing or triplexing equipment for furnishing hot metal to the electrics.

In the new electric furnace plant of the Republic Steel Corp. at Chicago, "the largest in the world," 80-ton electric furnace heats take the output of 200-ton tilting open-hearths, which in turn may use blast furnace hot metal. At the plant of the Copperweld Steel Co., at Warren, Ohio, 130-in. special design cupolas with 12-ton converters supply hot metal to 40-ton electrics. Each cupola will provide the converters with about 600 tons per day of partially desulphurized iron which will be delivered as medium carbon dephosphorized steel to the electrics. It is estimated that this practice will more than double the production of electric furnace steel, formerly operating on cold charges.

The chief object in the application of the duplex or triplexing principle to the electric furnace is to increase the output. Unquestionably the use of hot metal instead of cold accomplishes this. But it is economically applicable only to large electric furnace plants. It has other advantages among which may be emphasized the use of scrap not otherwise applicable in cold charging.

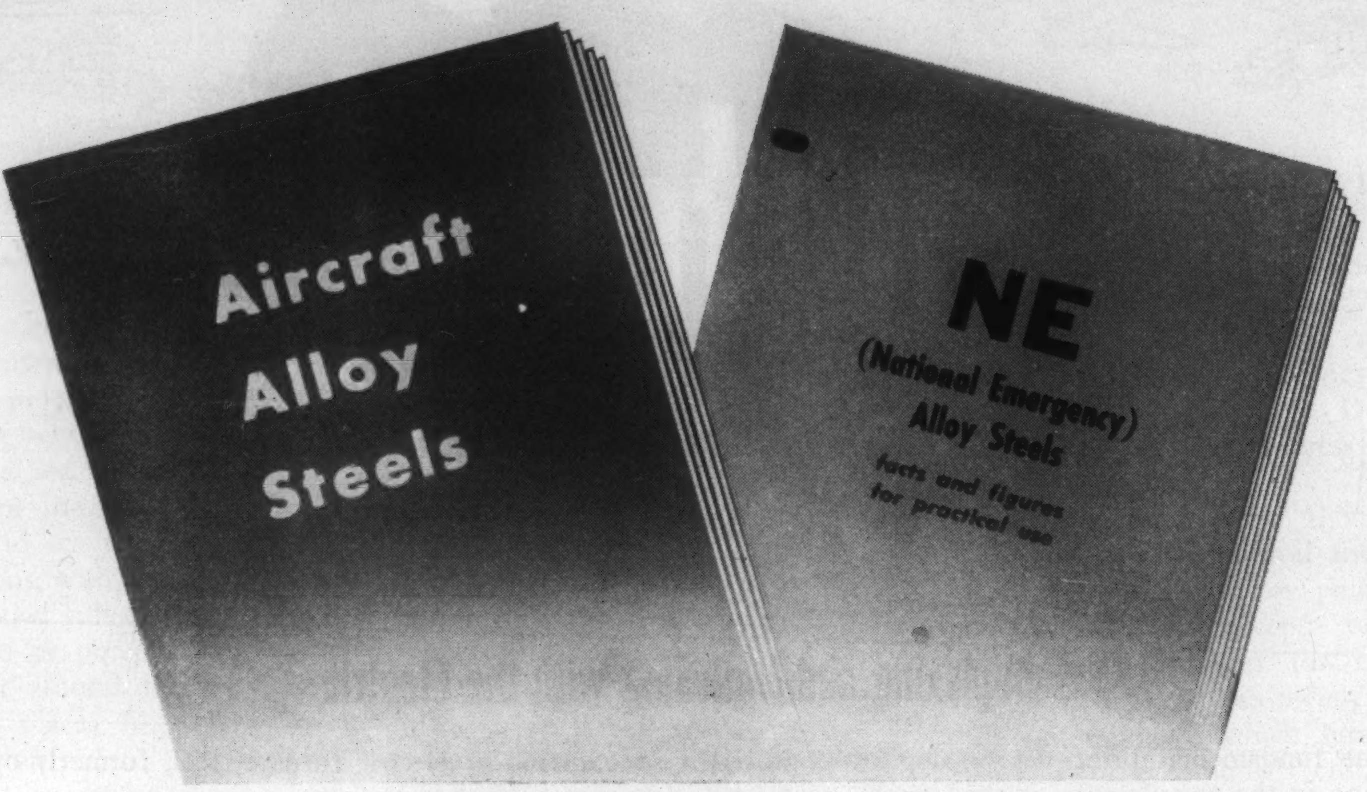
This new practice in electric furnace metallurgical technique is fulfilling a war need — high quality aircraft steels. The industry has expanded to very large proportions — over 6,000,000 tons capacity by the end of this year. What will be the status of this industry when peace comes? Will the speeding up of the output by duplexing or triplexing enable the process to compete with the open-hearth for certain grades now being made in such furnaces?

This and other problems, such as the employment of the tremendously increased capacity of the steel, pig iron, aluminum, magnesium and other industries, will have to await an answer until after the war is over. It is not, however, too early to give serious consideration to their solution. —E. F. C.

The War Effort and Post-War Planning

Industrial magazines have become a resonant sounding board in recent months for two kinds of editorial pronouncements. Readers have probably already classified these as (1) pointed urgings to take thought now on the problems of tomorrow and to set aside "an eighth day" or "Sunday afternoons" for constructive planning, together with discussions of the new materials and processes that may be available, and (2) warnings that the defeat of Germany and Japan is still far away and that a complacent sense of culmination can painfully prolong the war.

Comment along both of these lines has recently appeared in METALS AND ALLOYS, and we have thereupon been charged with vacillation and inconsistency. One correspondent asserts that "the



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RYERSON STEEL-SERVICE

June issue was dripping with post-war plans which gave the impression — whether you wished it or not — that the victory was in the bag. Then comes 'No Coasting!' in July — a clumsy about-face in which everyone except METALS AND ALLOYS gets hell for spreading the idea that we can now coast through to Victory.' "

We do not consider it at all inconsistent to foster an open-eyed awareness that Americans must work harder than ever for Victory at the same time that we discuss post-war materials and their utilization. Post-war planning is not necessarily predicated on an early victory — in fact the most intelligent planning assumes that *a long fight is ahead* and that the earlier planning-for-peace is begun the sweeter will be the ultimate fruits of Victory.

We *do* recognize, however, that many people will mistakenly and unfortunately read between the lines of articles or editorials on post-war materials an implication that the war is virtually over. So we now solemnly state that in our columns such implication was never intended in the past nor should it be inferred in the future. The individual editors of this magazine may have varying opinions on many things (we hope they always will), but they have been in complete agreement on our editorial policy with respect to the war effort and post-war planning. And for the record (which may be checked against past or future editorials), that policy is simply this:

(1) A long fight, requiring no let-up in our production effort, is ahead before both the Japs and Nazis are beaten.

(2) Without permitting any diversion from the war effort, engineers and manufacturers should give some thought to post-war problems and keep informed on the new materials, processes and products that may concern them.

(3) The more attractive we can expect our "industrial hereafter" to be, the more aggressively will we work and fight to assure its establishment! —F. P. P.

More and More About Less and Less

Viewing the impact of the war upon industry, engineers wonder mentally and in print what its effect will be upon their own profession. They should remember that the engineer is a war baby, and doing nicely, thank you. Not of this war, nor of the one before it, nor of any special war, but of war in general.

The first engineers were military engineers. They constructed catapults, javelin throwers, defensive walls about cities, siege towers, and similar engines of war and means of defense. They stood with Alexander's phalanxes on Eastern battlefields, marched with the Roman legions through the then-known world, and left their mark upon civilization in roads, aqueducts, and bridges which are in use today. By the middle of the thirteenth century armies included a special corps, including blacksmiths, carpenters, tentmakers, miners, armorers, and so on, under the command of an engineer.

It is interesting to note that the early military engineer was always an officer. Even the skilled corps which he commanded was not known as an "engineer corps," but as "military artificers," or "miners and sappers." The designation "engineer corps" to apply to an entire army unit is of comparatively recent origin.

Few present-day engineers realize how recently their profession attained civil status. It was not until the early eighteenth century that there came to exist a recognized body of non-military men devoted to the construction of roads, canals, bridges, breakwaters, docks and so on. They were called "civil" engineers to distinguish them from their military counterparts. As technical knowledge increased there grew out of this branch mechanical engineers, to deal with the steam engine, machine tools, and moving machinery in general; then mining engineers, to specialize upon the location and working of coal and ores; then naval architects, marine engineers, sanitary engineers, chemical engineers, electrical engineers.

Today there is a separate branch of engineering for almost every major type of operation or branch of industry. The field of mechanical engineering has been subdivided into metallurgical engineering, process engineering, tool engineering, welding engineering, power plant engineering, aeronautical engineering, machine design, refrigeration engineering, materials engineering, automotive engineering, ordnance engineering, maintenance engineering, hydraulic engineering, diesel engineering and many others. Some of these subdivisions have already divided in their turn.

The growing fund of technical information has made necessary this division and specialization — this "knowing more and more about less and less." War has speeded up scientific and industrial development, as it has always done. The permanent retention of most of these recent subdivisions of the engineering profession, many truly war babies, plus a continuing specialization may be confidently predicted.

With it there should be a continued and growing recognition of the importance of the engineer in a society the needs of which are so closely bound to his skills. —K. R.

Which Form of

Materials problems for the designer involve much more than just deciding which metal or alloy to use for a specific application. Questions of metal-form or fabricating method are equally important. In this article (one of the chapters in Mr. Chase's forthcoming book on designing for quantity production) some of the design, cost and production factors that are involved in choosing among non-ferrous sand castings, die castings, permanent-mold castings, plaster-mold castings, small centrifugal castings, etc. for high-production work are discussed.—The Editors

DESIGNERS OF NON-FERROUS CASTINGS usually have to decide, sooner or later, which of various types available they shall choose as best suited to their needs, at least when the castings are of small to medium size. A great deal depends upon such factors as: Number of castings, cost of the rough casting, cost of machining, cost of tooling, size and shape of casting, type and size of cores, kind of metal, section thickness, tolerances necessary and facilities available—to mention only a few considerations.

Detailed comparisons between die castings and permanent mold castings have appeared in METALS AND ALLOYS and similar comparisons between die castings and sand castings have been published elsewhere. Less has been written, however, about castings made in plaster molds and of those produced by centrifugal means. Both these types have somewhat specialized utility. Though their uses are not widespread, each of these two types has its peculiar advantages and limitations.

There are, as explained later, good reasons for differentiating as among die castings produced in machines of three different types and for comparing these types with other metal mold castings as well as with castings made in sand molds and in plaster molds. Such comparisons have been made in tables prepared originally by the General Electric Co. and here reproduced in somewhat modified form.

To use these tables intelligently one must first bear in mind that they apply only to *non-ferrous* castings and the preferences are made on this basis. Beyond that the important considerations discussed in the remainder of this article must also be remembered.

Sand castings usually involve low pattern costs and have widest use. They involve high labor cost because a separate mold is needed for each casting (or group of castings if match plates are used) and because cores have to be made and inserted separately. In addition, machining costs are often high. It is possible, however, to produce sand castings rapidly and to employ alloys difficult to cast in metal molds and/or which have melting points so high that metal molds, if used, have short life or tend to check and to yield rough castings. Sand castings, being formed against granular surfaces, are themselves comparatively rough and fine details are not sharply reproduced. It is difficult to hold close dimensional limits, especially where cores are involved. Nearly all alloys can be sand cast, including the "white" metals based on aluminum, on magnesium and on zinc.

The design aspects of sand casting were previously discussed by Hindle in METALS AND ALLOYS, April, May and June 1943.

Plaster of Paris Mold Castings

Although excellent castings, especially in small sizes, can be produced in *plaster of paris molds,* the process is restricted in its application and is employed in relatively few foundries. Metal patterns are needed for production runs and coring possibilities are rather limited as compared with metal mold castings. Molding cost is probably higher than for sand castings, but this is often offset by closer dimensions resulting in lower machining costs. Sharper outlines and smoother surfaces than in sand can be secured, but not so sharp as for some metal molds (especially for die castings). Though dimensional limits as close as those for metal molds are claimed, it is doubtful if they are as close as for die castings.

Because plaster molds have low thermal conductivity, thin walls can be cast, but slow cooling is a disadvantage in respect to strength and to hardness, at least in aluminum alloys. Thinner sections can be had in die castings than in plaster mold castings, at least in zinc and in aluminum alloys and, for these alloys, superior smoothness can be attained in casting dies than in plaster. For brass the reverse may be true except, perhaps, where casting dies are new or newly dressed.

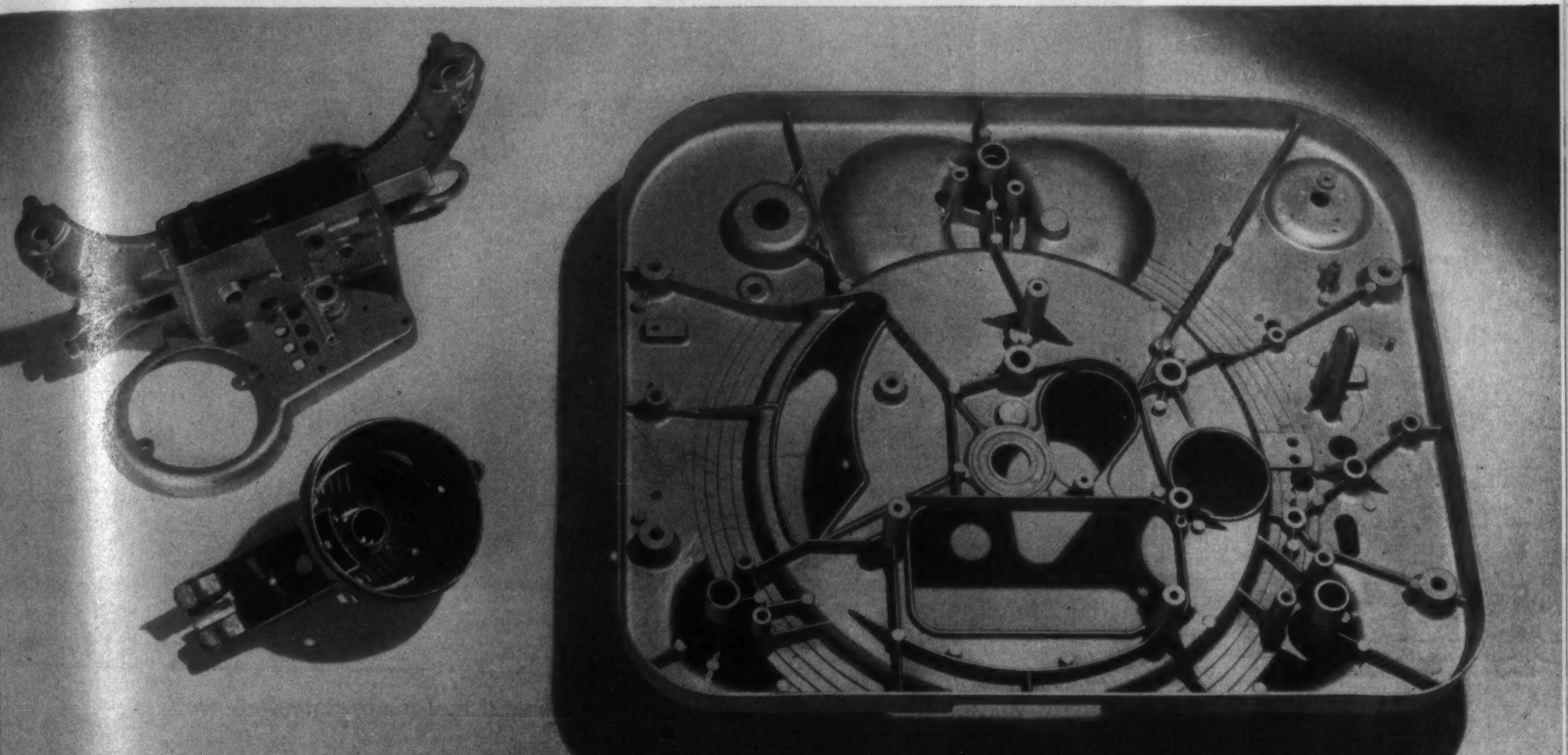
Some authorities state that there is less chance of internal porosity in plaster castings than in sand castings, but whether or not the conclusion is based upon strictly comparable conditions the present author does not know. Slower cooling results in lower strength and lower hardness in the case of aluminum alloys (but some question this in the case of copper-base alloys) than when more rapid chilling, as in sand and in metal molds, takes place. This may be favorable in respect to ease in machining, but presumably not in respect to wear resistance.

It is probable that any cost advantage which the plaster mold casting has over metal mold castings (when quantities involved warrant the cost of a metal mold or die) decreases as the melting point of the alloy decreases. This is because the plaster mold, being used only once, is not greatly affected by high temperature whereas metal molds are materially affected by high temperatures. Some alloys

Non-Ferrous Casting?

By HERBERT CHASE

Die castings typical of those produced in various alloys. Three at top are in zinc alloys and are produced in conventional plunger machines. Four in lower left corner are in aluminum alloy, the two larger ones at least, being made in cold-chamber machines, as are also the four castings in lower right corner, of which the box with cover is in magnesium alloy and the remaining two are brass die castings.



Group of castings produced in plaster of paris molds. Four castings at top are in Alcoa No. 355 silicon-aluminum alloy and have walls about 1/16 in. thick. Smallest casting, lower left, is also aluminum. Remaining castings are 60-40 yellow brass with walls about 0.070 in. thick, except the handle which has been cast in both brass and aluminum. (Atlantic Casting & Engineering Corp.)

which cast well in sand and in plaster molds melt at too high a temperature for economical casting in metal molds. Metal molds serve well for aluminum and still better for zinc alloy, but for the brasses they are subject to rapid heat checking and thus have relatively short life. Where aluminum or zinc alloys are concerned, plaster molds are seldom used in preference to metal molds unless quantities required are so small that the cost of metal molds is not justified and then, as a rule, chiefly when smoother surfaces or closer tolerances than sand molds afford are essential.

Metal Mold Castings

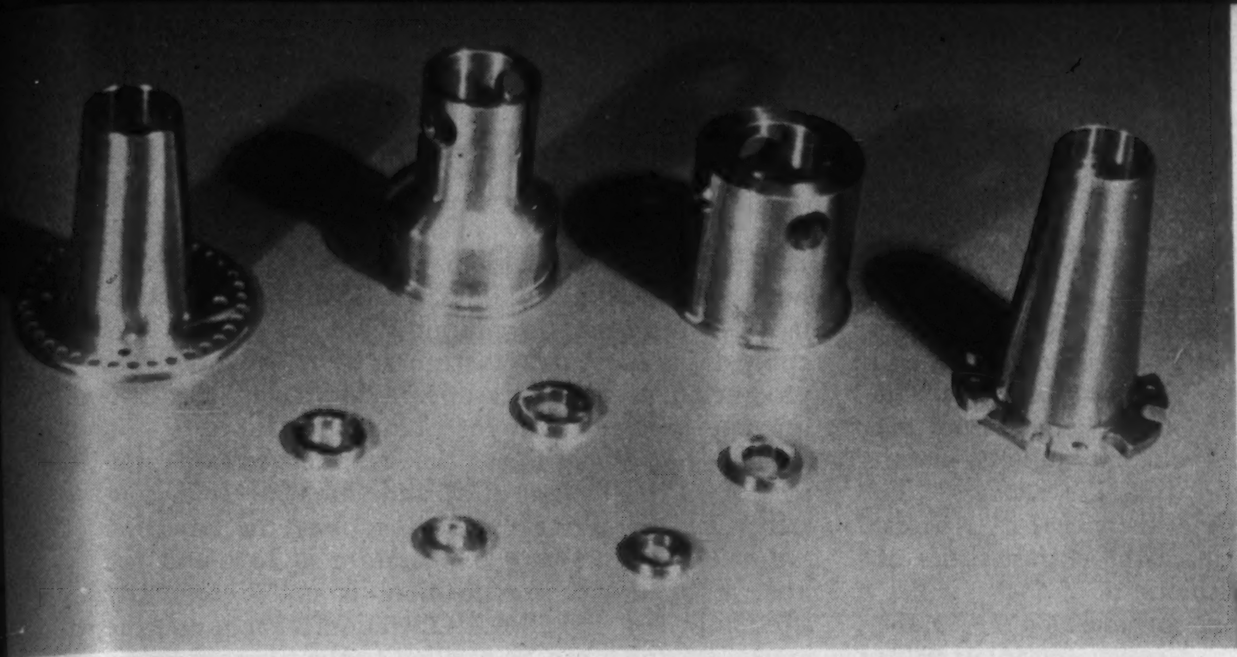
Metal mold castings are characterized by close tolerances and by relatively smooth surfaces and, for these reasons, require much less machining than sand castings and, in most cases, at least, than for plaster mold castings.

An outstanding advantage of the metal mold is that it serves for the production of thousands of duplicate castings—not, as for sand and plaster molds, for only a single filling. The labor for mold making is thus far less, as a rule, than for sand or plaster molds, providing a few thousand castings, as a minimum, are required. As quantities increase, the savings increase, as metal molds are not often worn out in service.

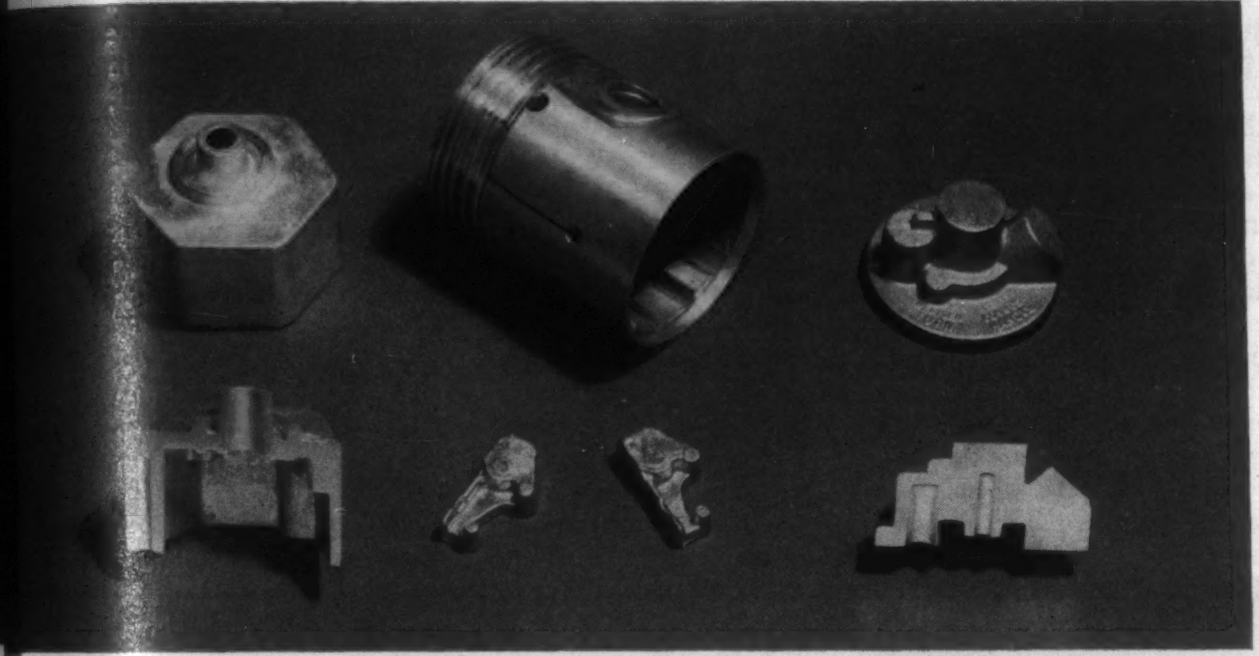
Such machining as is needed in metal mold castings usually involves light cuts which can be made at high speed on light machines. Where, especially in die casting zinc alloys, it is necessary to minimize polishing costs, preliminary to plating, dies can be made so smooth that only light buffing is needed (except at die partings) to yield an excellent surface for plating.

The same is true in so-called "slush mold" castings, a special form of permanent mold extensively used for zinc alloys. Such molds are not water cooled and their relatively hot surface (when it is highly polished) yields a casting which has a high luster without any polishing. The thin sections produced in die castings promote economy in metal and afford better surfaces for plating, as a rule, than do thicker sections.

All metal mold castings are rapidly chilled and thus yield a hard skin. The core is softer and, especially where sections are thick, porosity often occurs, as it frequently does, indeed, in thick sections of other forms of castings. By proper design and construction of dies, however, porosity can be largely confined to locations where stresses are light and where it is of little or no significance. Porosity can,



Typical non-ferrous centrifugal castings by Ampco Metal, Inc. Flanged parts are bushings for controllable - pitch propellers.



Permanent mold castings in aluminum alloys as produced by the Permold Co. Those sectioned indicate substantial freedom from porosity.

in fact, be so nearly eliminated as to be negligible for almost any type of part except those in which the expediency of using any type of casting is doubtful.

It is quite generally supposed that permanent mold castings are subject to less porosity than die castings, largely because the permanent mold casting is usually gravity poured and thus is not subject to violent surging or spattering in the mold. *As a generality,* this supposition may be justified, partly because conditions have not required that the die casting be made substantially free of porosity as long as the porosity is confined to non-critical areas. It is deserving of note, however, that, with the most modern technique, including production control using X-ray equipment, die castings can be made so nearly free of porosity as to meet even such exacting specifications as are applied to many aircraft parts. This involves the application of higher pressures than were once common and often necessitates considerable alterations in details of dies (especially gating and venting) before they yield the required results.

Contrary to some published conclusions, there are, as a rule, no exacting limitations upon the machining of metal mold castings (such, for example as one limiting machining depth to 0.010 in.). It is true that, since the chilled outer shell is the hardest and strongest part of the metal mold casting, it is good practice to avoid cutting through this wall *where maximum strength is essential.* It is also true, however that far greater depths of machining are common and that such cuts are made, as a rule, without any detrimental results whatever.

Walls of all thicknesses are drilled, tapped, milled, sawed, turned and otherwise machined to almost any depth, often clear through the wall. This need be done, however, only where some particular condition prevents casting to the required size, say where a core or slide are not feasible or readily applied or are not justified because the cost is greater than for machining. As in the design of any part for production by any means, the designer should make sure that strength is adequate for the load imposed, allowing, of course, for such machining as is necessary and applying the proper factor of safety for the type of product (whether cast, forged or cut from bar stock).

It is true that die castings are sometimes subject to blistering when exposed to high temperatures because of the expansion of gases confined in pores—providing, of course, that such pores exist, as they often do, close to the surface. This is not a serious limitation in most cases and, where it is, the die casting should either not be used or should be made substantially non-porous, as it can be with proper technique.

Types of Die Castings

Table I differentiates between die castings made in three types of machines but *in its original form* did not take due account of the plunger type of machine used today more widely than any other type, but chiefly for zinc alloys as it is not applicable to aluminum, magnesium or copper base die castings. To make proper use of Table I, therefore, it is necessary to know something about the characteristics of the respective types of machines.

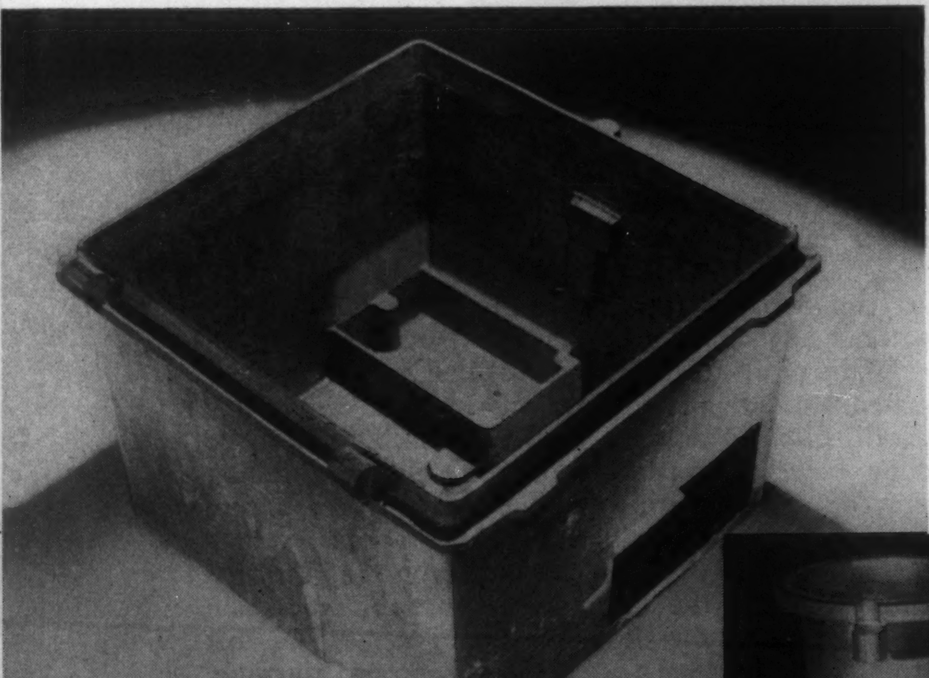
In the *gooseneck* (direct air injection) *type* the metal is held in a pot (closed except for an air valve and a gooseneck outlet) and is forced into the die by admitting air under pressure to the confined space above the metal. The pressure in such machines is usually limited to about 500 to 600 lbs. per sq. in. maximum. Today, such machines are used chiefly for aluminum, although they can be used for zinc alloys. As the iron pot and its gooseneck are washed inside and outside by molten aluminum, the latter rapidly dissolves the iron which makes the alloy brittle, reduces its ductility and castability and makes it harder to machine.

Life of the parts exposed to the molten aluminum is short and castings, though satisfactory for some purposes, (until iron content exceeds allowable limits) are apt to be porous and somewhat undependable, scrap often being high especially when considerable porosity is not permissible. The casting rate is rather low, seldom exceeding 110 shots an hour with aluminum alloys. Zinc alloys do not attack the metal parts significantly but the low pressure applied in gooseneck machines is not favorable to production of sound castings. Moreover, the casting rate is lower than for plunger machines.

In *plunger* machines, the cylinder remains immersed in the molten alloy and the alloy is in contact with the plunger which applies the injection pressure. The casting temperature is low and the iron, if of proper composition, is not significantly affected by the zinc alloy. Operation is rapid and the pressure (which can be applied to the plunger by air or by hydraulic means) can be as high as desired. As the metal is highly fluid, however, and fills the die rapidly, it has yet to be proved that pressures in excess of 2,000 lbs. per sq. in. on the metal result in any substantial gain though pressures of 3,000 to 5,000 lbs. have been tried. Today, the average pressure used approximates 1,500 to 2,000 lbs. Small machines run up to 400 shots or more per hour, but 250 shots an hour is a fair average, or more than double the maximum for gooseneck machines using aluminum alloys.

Cold chamber machines have gained rapidly in extent of use in recent years, especially for aluminum alloys, and are essential for die casting magnesium base and copper base alloys. They have an injection ram in a cylinder which is filled by ladling in molten or semi-molten alloy in quantities sufficient to fill the die and leave a small slug in that part of the cylinder within the die. This pressure is applied to the ram by hydraulic means and ranges, as a rule, from about 6,000 to over 20,000 lbs. per sq. in., the high range being chiefly for copper base alloys.

As the metal remains only a minimum time in the injection cylinder and is usually at the minimum castable temperature, iron pick up, even with aluminum alloys, is slight. The high pressure is favorable to the production of dense castings *provided* that the die design is correct originally or is altered (by trial



Sand cast pyrometer case in Zamak 3 (zinc alloy) which replaced a sand cast aluminum alloy part. The case measures 10½ x 11½ x 7⅜ in. and section thickness is about ⅛ in. (The New Jersey Zinc Co.).

Typical non-ferrous sand castings such as are used in aircraft applications. (Bendix Aviation Corp.)

Table I—Tolerances for Metal-Mold Non-Ferrous Castings

(These data for general guidance only. Special requirements in design often affect possible minima or maxima.)

Manufacturing Method	Metal	Dimensional Tolerances Commonly Possible Within Solid Die	Minimum Wall Thickness in Inches See Note 1	Minimum Cored Hole Diameter and Maximum Length in Relation to Diameter		Minimum Draft per Side Per Inch of Depth of Side Wall or Holes, Inches per Inch
				Diameter	Max. Depth In Relation to Diam.	
Remarks		Tolerances should be as liberal as possible in the interest of low die and casting cost, where it is not necessary to have same to the limits given below. Closer limits than those given in table can be had, but usually only at higher die costs. Tolerances affected by moving members must be somewhat greater (across parting lines, etc.).	Varying with alloys (Aluminum-silicon alloys, for instance will cast in thinner sections than aluminum-copper alloys.)	Cores for casting holes produce a beneficial chilling effect. Therefore, where possible, all holes should be cored, except when so small or deep that cores may be warped or bent under the shrinkage stresses of the freezing metal, or when drilling or punching is less expensive. Cores also save metal and machine work and also help to keep sections more nearly uniform in thickness.		Draft per side on walls where metal shrinks away from die can be somewhat smaller. Liberal draft results in superior surface finish and facilitates ejection of casting from die.
Die and Cold-chamber Casting	Magnesium Alloys	± 0.0015 in. per inch, but at least ± 0.003 in.	0.050 for small area. More for larger areas.	Smaller than 3/32 3/32 to ¼ ¼ to 1	Not cored 3 times 3-5 times	0.010
	Aluminum Alloys	± 0.0015 in. per inch, but at least ± 0.003 in.	0.035 for small area. More for larger areas.	Smaller than 3/32 3/32 to ¼ ¼ to 1	Not cored 3 times 3-6 times	0.010
	Zinc Alloys	± 0.001 in. per inch, but at least ± 0.0025 in.	0.020 for small area. More for larger areas.	Smaller than 3/32 3/32 to ¼ ¼ to 1	Generally not cored 3-8 times 6-8 times	0.005
	Brass and Bronze	± 0.003 in. per inch, but at least ± 0.005 in.	0.050 for small area. More for larger areas.	Smaller than 3/16 3/16 to ¼ ¼ to 1	Not cored 2 times 2-4 times	0.015
Permanent Mold Casting	Magnesium Alloys	± 0.0015 in. per inch, but at least ± 0.010 in.	0.1875 (regardless of whether surface is rough or smooth.)	Smaller than ¼ ¼ to ½ ½ to 1	Generally not cored 3 times 3-6 times	0.015
	Aluminum Alloys	± 0.0015 in. per inch, but at least ± 0.010 nn.	0.125 (0.090) where at least one side can be made reasonably rough.	Smaller than ¼ ¼ ¼ to 1	Generally not cored 3 times 3-6 times	0.015
	Bronze	± 0.005 in. per inch, but at least ± 0.010 in.	0.075 for small area. More for larger castings.	Smaller than ¼ ¼ to ½ ½ to 1	Generally not cored 2 times 2-4 times	0.020

Note 1: The minimum wall section which can be cast with different alloys and by different processes is not absolutely fixed. It depends on the size and design of the casting, location of the section with reference to heavier adjacent sections, on the die, the alloy type of machine, and the pressure applied. In general, the lower the melting point and the more fluid the metal, and the shorter the distance the metal must flow between the chilling walls of the die or mold, or the *faster the metal traverses the distance,* the thinner the wall may be. There is practically no limitation on maximum wall thickness. Sections somewhat heavier than minimum castable are recommended (especially for die and pressure castings) when castings are to be plated, as surfaces are apt to be smoother.

Finishes: Metal-mold castings can be finished with three different finishes as follows and should be marked on drawings to designate type of finish desired:

No marking—Commercial: Standard finish produced by commercial, but carefully controlled, routine.

Decorative: (Required for plating) Free from flow marks and from swirls and other surface imperfections.

Poorer than commercial; suitable for unexposed or painted surface.

and aid of X-ray of castings) until optimum conditions are secured. Zinc alloys are readily cast in cold chamber machines, but as such machines have yet to demonstrate any advantage over the plunger type *with zinc alloys* and are much slower to operate (about 90 shots an hour is near the maximum yet attained, as far as the author has been able to learn) the cold chamber machine is rarely used for zinc alloys.

Excellent castings based on aluminum, on magnesium and on copper are produced in cold chamber machines but the copper base alloys, because of the high casting temperatures, are hard on cylinders, rams and dies. The sound castings produced, especially in aluminum and in magnesium alloys, have led to their extensive application as aircraft parts, especially for secondary or lightly stressed parts.

There is little doubt that aluminum die castings produced in the cold chamber machine are denser than those produced in gooseneck machines and that limits on iron content are much more readily held. Some aluminum alloys suitable for cold chamber machines are difficult or impossible to cast in the gooseneck type. But for zinc alloys there appears to be no advantage in cold chamber machines over the plunger type machine, since pressure applied to the metal can be as high in the plunger machine as it is advantageous to employ.

Pressure applied in casting is not necessarily the criterion upon which to judge die castings even in respect to soundness, but too low a pressure is certainly to be avoided. Clearly, too, there is no point in using higher pressures than are needed to gain satisfactory results, as then a heavier and slower machine must be used. Where substantial freedom from porosity is essential, it is often more helpful to alter details of die design, especially gating and venting, (not necessarily changing the shape of the casting of its size) than to boost the pressure above that known to yield sound castings satisfactory for given needs.

Centrifugal Castings

Centrifugal castings mentioned in Table I are a special form of casting often made in permanent molds but having rather limited application. They are made chiefly (in non-ferrous castings) in copper base alloys and in bearing alloys. The chief merits of the process are in applying considerably higher pressures than in gravity castings, thus tending to make castings which are dense, and of excluding dross which is forced toward the inner wall of the bore and is machined away subsequently. Though centrifugal castings are not necessarily limited to shapes symmetrical about the axes of rotation, these are most common, and the feasible shapes are limited.

Table I applies *only to metal mold castings* and, as indicated, the data are for *general guidance only* as particular design conditions affect tolerances, minimum wall thicknesses, minimum core size and, in some cases, even the minimum draft feasible.

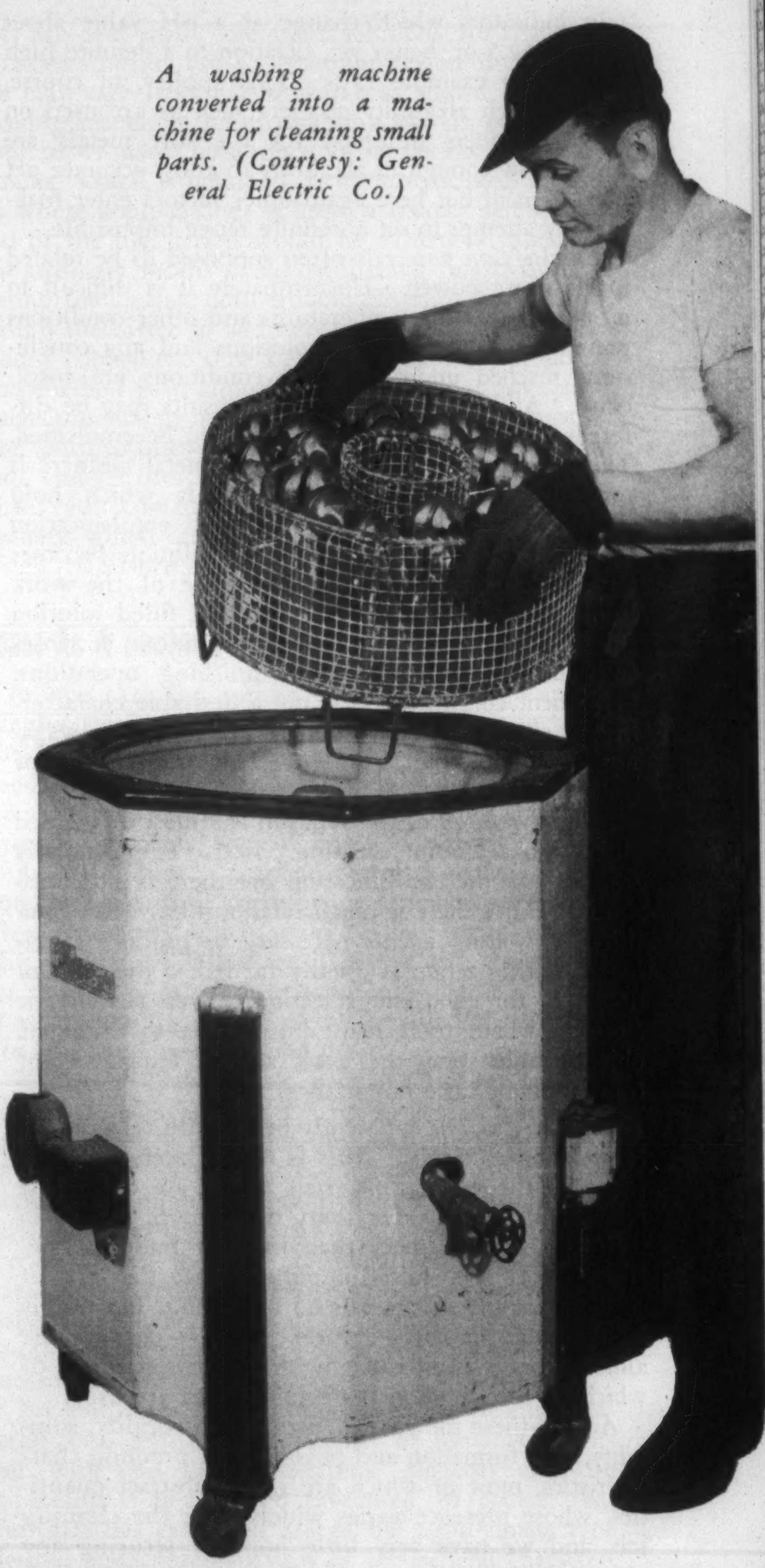
Table II, even in the revised form here presented, may still leave questions concerning certain of the relative ratings under some headings. As with other generalizations, it is certainly subject to exceptions in particular cases. The original presumably was based, however, upon extensive experience in the production or in the purchase of most or all the types of castings covered and, partly for this reason, may well prove helpful as a general guide. Table II, in its present form, is believed to be open to fewer objections than in its original form. In making specific applications, however, it is well to weigh all the significant facts and all conditions to be met, and to balance these before making a final choice.

Table II—Relative Design Characteristics of Different Non-Ferrous Casting Methods

(Numbered in order of preference, No. 1 being the most desirable)

Characteristic		Sand Castings	Plaster of Paris Mold Castings	Centrifugal Castings	Permanent-mold Castings	Gooseneck Die Castings	Cold Chamber, Pressure and Plunger Die Castings	Remarks
Porosity		6	2-1	1-2[a]	3-4[b]	4-5	4-3	[a] Ratings pertain to metal left after removal of drossy material from inside wall. [b] Ratings pertain to material next to metal mold in case of semi-permanent molds. [c] May be 1 for copper-base castings. [d] Inferior in strength to sand castings in aluminum alloys but possibly superior to sand castings in copper base alloys.
Surface smoothness		6	3-4[c]	5-4[a]	3-4[b]	2-3	1	
Sharpness of outline		6	3	4-5[a]	5-4[b]	2	1	
Strength (solid metal)		5-6	6-5[d]	3[a]	4[b]	2-1	1-2	
Thinness of section		5	3[c]	6	4	2	1	
Cost of tools, patterns, dies or molds		1	2-3	3-2	4	5-6	6-5	Tool cost and cost per casting depend on number of patterns per plate or impressions in die; the more castings can be made at one operation, the lower the labor cost per piece, with inversely increasing tool cost. Sand and plaster of paris patterns lend themselves more economically to multi-impressions than metal molds. The labor costs considered here include those for making the pattern, match-plate, metal mold or die. The ratings are on the basis of the most economical tool set-up (as to number of impressions on one pattern plate or in one die) for comparative production quantities.
Speed of production		4	5	5	3	2-1	1-2	
Labor per Cost Casting (as cast)	for small production	1	2	4	3	5-6	5-6	
	for large production	5	6	4	3	2-1	1-2	
Possibility to Save Machining		6-5[e]	4	5-6[e]	3	2-1	1-2	[e] May be reversed in certain cases.

Evaluation of Metal Cleaners



A washing machine converted into a machine for cleaning small parts. (Courtesy: General Electric Co.)

With metal cleaners playing so important a part in the general scheme of wartime metal-working, it is essential that engineers entrusted with their selection understand the factors that contribute to cleaning efficiency and life expectancy. Avoiding discussion or comparison of proprietary products, Mr. Strowe outlines in this article the significant properties of "good" cleaners and some of the methods that may be used to evaluate them. —*The Editors*

By HENRY STROW

MacDermid, Inc., Waterbury, Conn.

EVALUATION OF METAL CLEANERS is a very important item in today's production control and a great deal of work, some of it very excellent, has been published on this subject. With all this it is sometimes astonishing to the expert to find the same material under different names given entirely different ratings when used for the same cleaning job in the same equipment.

Evaluation of metal cleaners in any quantitative sense of the word has not made any great technical headway. In the field of laundry detergents a considerable degree of progress has been made and there are a number of fairly standard tests. Attempts have been made by a large number of investigators to develop a test which would accurately predict the performance of a metal cleaner, but so far no test has been successful on any extensive scale. There are a number of reasons for this. Probably the primary one is the lack of standardization throughout the industry as to methods and purpose.

Insofar as methods go there are countless variations. Standardization has probably been best achieved in the use of chlorinated solvents for cleaning, but this standardization has resulted in a definite limitation on the usage of the process. When specific finishes are mentioned considerable variation still exists in the cleaners to be used since many methods may be employed.

Significant Factors

Evaluation of metal cleaners has many times in the past been tied to many factors, among them pH, emulsifying power, surface tension, buffering action and other such physical properties. It is easy to explain why any of these fail as universal determinants of cleansing power.

Hydrogen ion concentration or pH ceases to have much meaning above a value of about 13 as we are then above all buffered ranges and the accuracy of determination is such that the variation is excessive. Much better than the pH determination is a titration back to an endpoint, such as the color change of certain indicators which change at a pH value about 12.0 to 12.5 or, better yet, titration to a definite high pH, as for example 12.6. This applies, of course, only to high alkalinity cleaners such as are used on steel. Cleaners designed for the soft metals are usually low enough in alkalinity to allow accurate pH measurement but here again other factors enter making any attempt to set a definite range impossible.

Emulsifying power is often supposed to be related to cleansing power. Unfortunately it is difficult to measure under the temperatures and other conditions present in metal cleaning solutions and any conclusions reached under different conditions are suspicious. Add to this the fact that results may be different when different materials are to be emulsified. The exact role of emulsification in metal cleaners is somewhat problematical as materials which hold the soil (oil, dirt, etc.) in permanent emulsification are not too desirable because the solution becomes rapidly contaminated and the surface of the work being cleaned still has a layer of dirt filled solution and it may cause trouble by precipitation in rinses and subsequent trouble with finishing operations. Permanent emulsification is not a desirable characteristic in electrolytic cleaners or in pressure spray washing machine cleaners as here again this type of emulsification tends to produce excessive foam.

Surface tension of the solution is a most misguided attempt to determine cleaning power. It is generally tied in with the emulsification but there is little reason to believe there is much relationship. The quantities of wetting agents necessary to produce maximum wetting action is usually far below the amount necessary for good emulsification. Even for electric cleaners where their main purpose is to eliminate objectionable spray the exact surface tension is of comparatively little importance.

Buffering action apparently bears little relationship to cleaning efficiency. This is readily seen from the fact that the various materials which are commonly used in alkaline cleaners vary much more widely in their cleaning efficiency than in their buffer action. It is, of course, fairly important that the pH of cleaners for the soft metals do not change too widely with change in concentration, but the changes are almost always approximately the same regardless of which of the common buffered alkalies are used.

Add to these the characteristics of rinsability, solubility, film formation and possible rust proofing characteristics, most of which are rather abstract quantities, whose presence varies widely with the cleaning job, and we have very little hope of securing any universal tests using the physical or chemical characteristics of the cleaning solutions. This, however, does not mean that any of the foregoing characteristics or a combination of them or other characteristics cannot be a valuable means of checking for any particular cleaner or cleaning job, but this must be determined after full consideration of the facts of the case involved.

The characteristics mentioned apply with particular emphasis to the common alkaline cleaners, but their use may be extended to solvent emulsion cleaners, acid cleaners or other combinations. The best conclusion that can be reached is that there is no substitute yet for actual evaluation of any cleaning material or method on the job to be done. This may be accomplished through the use of pilot lines or through properly conducted laboratory tests which will weed out the materials which will obviously not be suitable. Many minor factors which are often the crucial factors can only be determined through production runs.

Tests for Cleaners

Inasmuch as the use of a material or method in any production is usually subject to a great many personal equations, many attempts have been made to put the cleanliness on a more scientific impersonal basis. The launderometer has performed this operation so far as detergents for cloth go and arrives at a fairly impartial result, although it does not measure all of the factors desirable. The most complete and least empirical test yet devised is that developed by Morgan and Lankler, which was recently published giving complete details. The method used a standard soil produced in a reproducible manner on test panels. These are photographed under ultraviolet light giving fluorescence from unremoved oil.

This method holds great possibilities for use in evaluating cleaners, especially prior to organic finishing, before inspection and for inter-departmental cleaning. To the disadvantage of the method it must be said that it does not give a record of removal of smut which it is desirable to remove before electroplating operations; also in the case of certain cleaners an oil film is desirable for rust prevention. For use on aluminum, magnesium and some of the other nonferrous metals as well as on selected applications on steel this affords a very good appraisal of cleaning efficiency. Such things as rinsability and drag-out losses may also be quantitatively determined by simple laboratory tests. Too much reliance, however, should not be placed on any such tests until they have been carefully correlated with practical results. It is not safe to attempt to transfer such results from one job to another without checking carefully the practical results.

The problem of properly selecting the most efficient cleaner could be greatly simplified if we could develop, ahead of time, the exact requirements to be met and know the factors affecting these, but this is usually a case of excellent hindsight and the experimental work is done on the production line. Such small items as temperature of rinse waters, amount of flow of rinse water, racking of work, hardness of water, transfer time between operations, and even atmospheric conditions may affect results and it is seldom possible to accurately predict all these and many other factors.

Life Expectancy

Evaluation of metal cleaners is hardly complete, however, without a determination of the life. Cleaning efficiency is of little value if the life expectancy of the material is too limited. The determination of this all important factor has received too little attention in the past. Most of the tests have consisted of measuring the cleaning efficiency after measured additions of contaminant. Inasmuch as measurements of cleaning efficiency are comparatively inaccurate the inclusion of this new variable which holds great possibilities of error is hardly conducive to any possibility of universal application. By the application of the method of Morgan and Lankler it would be possible, however, to secure good results with selected jobs, such as the removal of oil from aluminum where measured amounts of the oil would be added until the limit for good results was reached.

Determination of the cleaning efficiency or adaptability for any given job and the determination of the probable length of life is only half of the problem of evaluation of metal cleaning. The maintenance of the original efficiency and the determination of the end of the useful life are the other half.

In the case of cleaning with chlorinated solvents the maintenance of the original efficiency is comparatively simple as is also the determination of the end of the useful life of the solvent. These have been carefully worked out and owing to the high degree of standardization are of universal application.

Water solutions as cleaners are another story. Here the contamination does impair the efficiency and the problem lies in maintaining the efficiency at as high a point as possible. Control of concentration is, of course, of primary importance. For alkaline cleaners this may be simply accomplished by titration of the total alkali as composition of the cleaner seldom varies except where other alkalis or inorganic salts are dragged in. This maintains the original strength of the solution to insure uniform results so far as re-action with the metal involved, conductivity, etc. Where a considerable amount of organic detergent or other important constituent is present, it is frequently desirable to determine this separately as it may be removed from the solution at a different rate than the other components. In some cases this can be fairly easily accomplished by treatment with acid and measuring the residue or by extraction with an immiscible solvent. These are often open to question as the possibility exists that a portion of the contaminating material may also be measured. It is also possible to develop colorimetric or other simple tests to determine these components with the requisite accuracy. Emulsion cleaners and other organic cleaners are also best handled by the means outlined above for organic components.

Special tests must be developed to meet special conditions. Thus for cleaners which must be absolutely non-staining, accelerated tests are frequently desirable. Specific recommendations can usually be given by the manufacturers if proprietary compounds are used. Special characteristics are usually known and tests developed if they have not already been developed.

The second problem, that of determining the end of the useful life, is somewhat complex. Very few tests are ever made and most solutions are changed at rather arbitrary times. Since the period of effective life may vary from a few hours, as shown in many washing machines, or in tumbling barrels where the solution is used only once to a period of many months, which is obtained by electrolytic steel cleaners where a pre-cleaner is used, a correct determination of the life period would be extremely valuable. The ordinary means of accomplishing this is by operating the cleaner until trouble develops and by operating thereafter so as to change the solution at the nearest convenient time before the expected trouble. This method is in almost universal use but especially where production is non-uniform in character or volume tends to discard the solution before the approximate end of life. Trouble may also be experienced when extra contamination is introduced. There are methods which can be used, but these have not been widely published.

Foam As A Factor

In one case the author, in checking a group of samples from cleaner tanks at various stages in their use, found that the volume of foam produced under standard conditions was reproducible and that, when the volume of foam was half the volume of the same cleaner when new, the solution had reached the end of its useful life. Complete chemical analysis of organic and inorganic constituents failed to reveal any other conditions which could be used as a measure. This method while not sensitive was accurate enough for shop use. Thus it is possible to devise a means of evaluating the life of metal cleaners although few attempts have been made to do so.

With the present war program calling for improved cleanliness of metal products, for many reasons and in view of impending and current shortages of many of the metal cleaning components, it becomes increasingly important to do some constructive thinking about the problem. Equipment and methods are of course, the first considerations. Once these have been determined the selection of proper materials through sound evaluation is necessary. Once a sound basis for evaluation is arrived at, the selection becomes much less difficult.

To summarize briefly, evaluation of a cleaning material with regards to possibility of use involves itself with two things—cleaning efficiency and life expectancy. It must be presumed, of course, that the materials examined are of the approximate type desired and chosen in view of the general characteristics of the job to be done from a material and method standpoint. Methods exist for determining these two characteristics, although too much dependency should not be placed on the absolute quantitative results obtained. Once the selection of a material has been made, the evaluation continues as control. Control of concentration is usually readily achieved. Evaluation of the end of useful life is less easily done and the final result is usually an empirical schedule for changing solution which in many cases fails to utilize the full potentialities.

Cold-rolled stainless steel strip is annealed in a continuous operation, the metal slowly passing through the annealing furnace. (Courtesy: United States Steel Corp.)

High-Manganese Stainless Steels

A Correlated Abstract - Part 1

The development of commercially useful stainless steels in which all or part of the nickel in the popular "18 and 8" steel is replaced by manganese has been sharply accelerated by the heavy diversion of nickel to several other wartime uses. As a result engineers will welcome the appearance of this correlated abstract—a critical review of the published information on these chromium-manganese and chromium-manganese-nickel stainless steels, covering their working properties, mechanical characteristics, corrosion resistance, high-temperature behavior, structures, etc., and including comparative data for the conventional stainless steels. —*The Editors.*

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STAINLESS STEELS are basically alloys of iron, chromium, nickel, and carbon, although small amounts of other elements such as silicon, manganese, tungsten, molybdenum, aluminum, copper, columbium, or titanium are occasionally added to develop special properties. Of the four chief elements comprising stainless steel, there are no scarcities of iron and carbon.

The scarcity of chromium for steel manufacture is serious but not critical, since there are ample deposits of suitable chromium ore in many parts of the world, including the United States[44], necessitating only the development of domestic deposits or shipping capacity to make it available to American steel producers. The situation with nickel is much more serious since the only important nickel mines in the world are at Sudbury, Ontario. These mines produce almost 90 per cent of the world's supply of nickel.[44] Nickel is needed so desperately for military purposes that there is little available for use in commercial stainless steel.

Since stainless steels are so necessary in modern industry, the question logically arises, "Is there any metal available that can be substituted for nickel in austenitic stainless steels?" Accordingly, a search of the literature was undertaken to assemble information relating to the properties of stainless steels of the 18 Cr-8 Ni type in which another metal is substituted in whole or in part for the nickel.

Possible Substitutes for Nickel

Any metal that is to be used instead of nickel as an addition agent to iron-chromium-carbon alloys must have the same effect as nickel if the resultant alloys are to have properties that are essentially the same as those of austenitic stainless steels. Cobalt and manganese are the only metals that meet this requirement.[2] (Copper, like manganese, nickel, and cobalt, also is an austenite stabilizer, but cannot be considered as a possible substitute for nickel in 18 and 8 because, when present in amounts over 3 to 4 per cent, the copper causes red shortness.) Riedrich[39] and Uhlig[45] have shown that nitrogen can be a useful austenite stabilizer. Monypenny's comment[37] on the use of nitrogen in stainless steel is interesting. Of these two metals, only manganese is available commercially in amounts large enough to be considered.

About 40 per cent of manganese is necessary to produce stable austenite in iron-manganese alloys at room temperature[30]; manganese forms a carbide of the same general type as iron carbide in steel. The manganese carbide becomes associated with the iron carbide, or chromium carbide if present. From these facts one might conclude that manganese might be less successful than nickel in delaying the gamma-to-alpha transformation and that, by forming carbides, it would reduce the amount of chromium carbides precipitated when metastable austenite transforms to ferrite. Hence the manganese stainless steels should be less susceptible to intergranular attack. That this is true will be shown later.

Manganese, even in large amounts, has practically no effect on the corrosion resistance of steel.[1] Thus, it is to be expected that substitution of manganese for nickel in 18 and 8 steel probably would reduce somewhat its corrosion resistance.

As will be shown in the following discussion of the literature, it has been found necessary to add other elements to the manganese stainless steels to obtain properties comparable to those of the standard 18 and 8 stainless steels. Such substitute steels, particularly those containing 18 Cr, 4 Ni, and 4 per cent Mn, already are in commercial production.[43]

Structure of the Manganese Stainless Steels

The first report on the chromium-manganese stainless steels was made by Beckett[3], in 1930, who stated that his company (The Electro Metallurgical Corp.) had been working with these steels for a number of years. He found it impossible to produce a completely austenitic structure in an alloy containing 17.88 Cr, 8.26 Mn, and 0.07 per cent C even upon quenching from temperatures in the range of 900 to 1150 deg. C., (1650 to 2100 deg. F.), although he found that steels containing upwards of 7 per cent Mn and slightly higher than 0.07 per cent C are wholly austenitic in the range 1000 to 1150 deg. C. (1830 to 2100 deg. F.)

Working with a similar steel (18 Cr, 7½ Mn), Grossmann[16] found it necessary to increase the carbon content to 0.32 per cent before a completely austenitic structure (metastable) was retained upon quenching from 1150 deg. C. (2100 deg. F.) Khimushin and Kurova[20] found it necessary to have higher manganese and carbon (12 Mn, 0.32 to 0.42% C) and lower chromium (15%) to get a completely austenitic structure after quenching from 1150 deg. C. (2100 deg. F.). They could not retain austenite upon quenching in a steel like Grossmann's unless they added nickel and reduced the chromium content.

Parks[38] has found that alloys containing 12, 20, or 30 per cent Mn and 12 per cent Cr, and 12 or 20 per cent Mn and 5 per cent Cr are completely austenitic at 982 deg. C. (1800 deg. F.) Schafmeister and Ergang[41] state these alloys are austenitic at 700 deg. C. [1300 deg. F.]), but that they are mixtures of ferrite and austenite at room temperature regardless of the speed of cooling. The presence of ferrite in the 5 Cr, 20 per cent Mn alloy at room temperature is unusual and is ascribed to the very low carbon content of this alloy. Köster[24] indicates that 0.1 per cent C in this alloy will prevent formation of ferrite even with equilibrium cooling.

Gürzberg and associates[17] concluded that nickel is twice as strong as manganese in forming austenite in iron-chromium-carbon alloys. This was confirmed later by Burgess and Forgeng,[8] who reported that manganese has but a weak effect compared to nickel in stabilizing austenite in alloys containing 12 per cent or more chromium. As an example of this, Krivobok[25] points out that while Type 309 steel (25 Cr, 12 Ni, 0.1 C) is completely austenitic (treatment not stated), a similar steel containing 25.9 Cr, 11.2 Mn, and 0.15 per cent C is ferritic.

Examination of alloys in the composition ranges 5 to 12 per cent Cr and 12 to 30 per cent Mn has led Parks[38] to conclude that increasing chromium content in this range has little effect on the amount of ferrite rejected from the austenite during cooling, while increasing manganese content definitely suppresses decomposition of austenite. Gürzberg was not able to obtain a purely austenitic structure even with 16 per cent Mn in straight chromium-manganese steels, although austenite could be retained with 7 per cent Mn and 2 per cent Cu or with 2 per cent Mn and 6 per cent Ni.

Mitchell[35] recommends addition of nickel or copper or both, in addition to the manganese, to insure presence of more austenite. The combined effect of manganese, copper, and nickel in stabilizing austenite is shown in Armstrong metal[15], which analyzes, in per cent: Cr, 17½; Mn, 4 to 6; Cu, 2.9; Ni, 8; and C, 0.10. This alloy remains completely austenitic even after cold-working.

Kinzel[22] finds the austenite stabilizing power of manganese and copper to be less pronounced. In an alloy composed of 18 Cr, 8 per cent Mn, 1 Cu, and 0.1 per cent C, he finds only 60 per cent austenite (balance ferrite) after quenching from 1050 deg. C. (1925 deg. F.). Brühl[7] agrees with Kinzel, although his work was done on an alloy containing 30 Cr, 15 Mn, and 1 per cent C. Fuchs[14] reports that if the manganese is raised to 12 per cent and the chromium dropped to 8 or 9 per cent, the alloy can be retained as austenite after rapid cooling.

In some later work Beckett[5], and Burgess and Forgeng[8] investigated the iron-chromium-manganese system and confirmed their earlier statements that the 18 and 8 chromium-manganese alloy is never completely austenitic at any temperature with carbon in the neighborhood of 0.1 per cent. In some recent work, Dean[10] found that ternary iron-manganese-chromium alloys made with electrolytic manganese have substantially the same behavior as similar alloys reported by Burgess and Forgeng in the austenitic range. Outside the austenitic range, however, he found that their behavior and properties are entirely different; he did not cite specific data.

There is evidence that the sigma phase or the compound, FeCr, can form in some of these alloys[7, 8, 18, 23, 28, 36, 38, 41, 46]. This tendency is enhanced by the fact that the chromium tends to concentrate in the ferrite, the manganese in the austenite[7, 38].

Working Properties

The austenitic stainless steels, because of their lattice structure, are generally more plastic than the ferritic chromium irons. This is particularly true for cold working despite the rapidity with which they work-harden. At high temperatures they require more power for working than do the ferritic irons because they retain their strength better. The mixed austenitic-ferritic types (such as Type 316) generally have working properties intermediate between the single-phase types. Since the manganese stainless steels are usually of the mixed type, their working properties can be predicted in a general way from their structures.

Manganese is added to the standard 18 and 8 steels (Types 301 to 306, incl.) in amounts up to a maximum of 2 per cent to improve the hot-rolling properties; frequently it is added to the special 18 and 8 steels containing molybdenum, cobalt, or titanium up to a maximum of 2.5 per cent for the same

TABLE I. Properties[a] of Some Stainless Alloys in the Annealed Condition

Property	18% Cr-iron (ferritic), Type 430	28% Cr-iron (ferritic), Type 446	18-8 stainless steel (austenitic), Type 304	18-8 Mo stainless steel (aust.-ferr.), Type 316
Yield point, p.s.i.	45-50,000	45-60,000	30-40,000	35-55,000
Tensile strength, p.s.i.	70-80,000	75-95,000	80-90,000	80-100,000
Elong., % in 2 in.	30-25	30-20	60-55	60-50
Reduction of area, %	60-50	55-40	75-50	70-55
Brinell hardness no.	160-180	150-200	135-160	140-190
Izod impact, ft.-lbs.	45-35	Low	120-110	120-80

[a] *Properties cited by Allegheny Ludlum Steel Corp.*[12]

TABLE II. High-Temperature Tensile Strength of Some Stainless Alloys[32]

°F. Temperature	Tensile strength, lbs. per sq. in.			
	17% Cr-iron (ferritic), Type 430	27% Cr-iron (ferritic), Type 446	18-8 stainless steel (austenitic), Type 304	25-12 stainless steel (austenitic), Type 309
Room	76,580	93,480	91,500	79,880
400	67,140	——	70,250	66,890
800	56,190	82,380	67,025	66,400
1200	18,650	24,210	44,375	44,680
1600	3,480	3,355	14,500	15,970

TABLE III. Creep Strength of Some Stainless Alloys[33]

°F. Temperature	17% Cr-iron (ferritic), Type 430	27% Cr-iron (ferritic), Type 446	18-8 stainless steel (austenitic), Type 304	25-20 stainless steel (austenitic), Type 310
Stress causing creep rate of 1 per cent in 10,000 hrs., p.s.i.				
1000	8,500	——	17,000	——
1200	2,100	1,600	7,000	7,400
1350	1,200	400	3,000	3,300
1500	——	——	850	1,100
Stress causing creep rate of 1 per cent in 100,000 hrs., p.s.i.				
1000	7,000	——	11,500	——
1200	1,600	1,000	4,250	5,400
1350	900	180	1,600	2,800
1500	——	——	——	800

purpose[35]. Beckett[3] found that the chromium-manganese steels he prepared in the composition range of 16 to 20 Cr, 8 to 20 Mn, and 0.07 to 0.23 per cent C had good deep-drawing properties, rolled well, could be drawn into seamless tubes, welded nicely, and could be polished easily. In the form of 0.035-in. sheet they can be spot welded under conditions used for cold rolled 18 and 8 and such welds exceed the minimum 1500 lbs. per sq. in. per spot required for stainless steels of this gage.[1]

Addition of more than 3 per cent Cu to the higher manganese steels resulted in red shortness. Grimshaw[15] reported the same thing. Beckett ascribed these excellent working properties not only to structure, but to the fact that it was easier to produce sound ingots with the manganese stainless than with other high-chromium alloys because of the scavenging action of manganese on the melt. He noted in a later paper[5] that these steels will stand greater amounts of cold-working than the standard 18 and 8 steels.

Kinzel[22] agrees with Beckett and states further that the steels containing 18 Cr, 8 Mn, 1 Cu, and 0.1 per cent C are easier to forge at high temperatures because they are a mixture of ferrite and austenite requiring less power than the straight austenitic steels, but are more plastic than the ferritic irons. Kinzel also found the manganese 18 and 8 to be easier to cold-roll than the standard 18 and 8 because it work-hardened less (yet more than the ferritic irons) and required no more anneals in processing.

Legat[28] stated that the chromium content of these alloys cannot exceed 15 per cent without the development of an excessively brittle compound in the structure. While the presence of this compound has been confirmed by other investigators[8, 25], its effect on the properties of the alloy has not been determined definitely. As previously stated, iron-chromium-manganese alloys made with electrolytic manganese apparently *may* have quite different properties than similar iron-chromium-manganese alloys presumably made with pyritic manganese.

Dean[10] cites one group, containing 18 to 20 Cr, 24 to 28 per cent Mn, and the balance iron, which is so ductile and malleable after suitable heat treatment (quenched from 1200 deg. C, 2200 deg. F.) that the alloys may be rolled into thin sheets or drawn into fine wire. These alloys apparently do not work-harden in the same way as the austenitic alloys and may be very extensively cold-worked. Machinability of chromium-manganese 18 and 8 is much superior to standard 18 and 8, which is notoriously difficult to machine, if the carbon content is not too high.[1] Legat[26] found the upper limit of carbon content for good machinability to be about 0.3 per cent C in these alloys.

Other investigators[14, 20, 35] agree that the chromium-manganese 18 and 8 alloys have good working properties. However, when elements other than nickel or copper (such as aluminum, silicon, molybdenum, and cobalt) are added to improve high-temperature strength, working properties may suffer[29, 40].

Mechanical Properties

A stable austenitic steel, because of its face-centered-cubic lattice structure, would be expected to have lower tensile strength, yield strength, and hardness plus higher elongation, greater reduction in area and higher Erichsen values than a stable ferritic steel with its body-centered cubic structure. Duplex structures, consisting of both austenite and ferrite, reasonably would be expected to have properties intermediate between the two single-phase types. However, the metastable austenitic steels (18 and 8) would have different properties because of the tendency of the metastable austenite to break down during plastic deformation to a hard, martensitic-like structure. Typical properties of these materials are shown in Table I.[31]

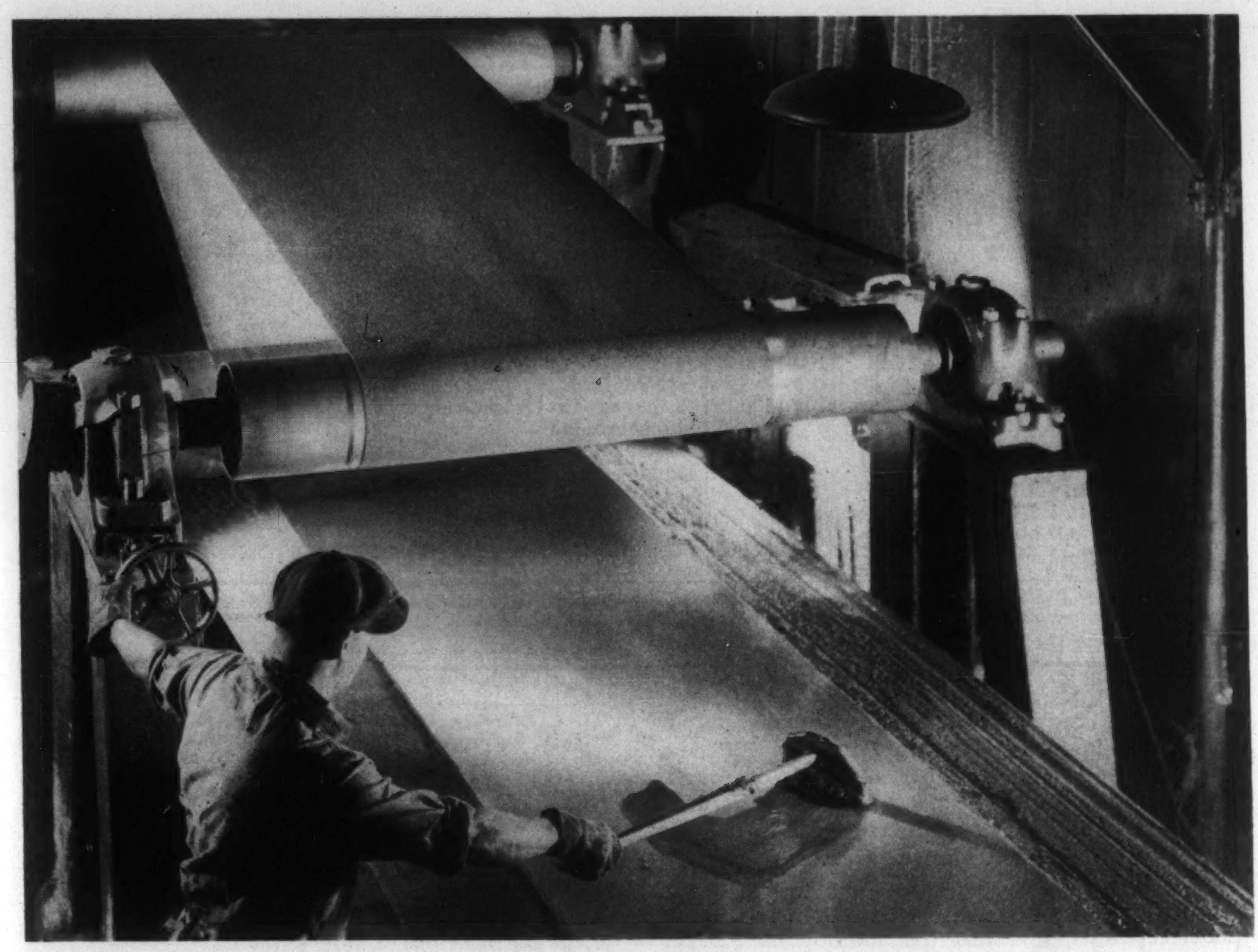
The room-temperature properties of the manganese 18 and 8 alloys and other alloys of the same type, when cited[14, 27, 36, 38, 42], generally lie within the same ranges given in Table I for standard 18 and 8 and molybdenum 18 and 8, with a tendency for some of the yield point, tensile strength, and Brinell hardness value to be higher. These reported higher values probably are due to the fact that many of the investigators used alloys with higher carbon contents than those listed in Table I. A comprehensive summary of the mechanical properties of chromium-manganese alloys of the 18 and 8 and 17 and 7 type, including alloys in which nickel has been sub-

TABLE IV. High-Temperature Tensile Strengths of Some Manganese 18 and 8 Alloys and Related Alloys

Composition of alloy, %	Heat treatment	Temp. of tensile test, deg. F.	Tensile strength[a], p.s.i.	Reference
18 Cr-10 Mn	Air-cooled from 1925° F.	1110	39,750	3
		1650	9,000	
22 Cr-14 Mn	——	Up to 1830	"Equal to 18-25 Cr-Ni steel" (which is 24,000 at 1650° F., 11,000 at 1830 deg. F.)	6
21 Cr-10 Mn	——	Up to 1830		6
18 Cr-10 Mn	——	Up to 1830		6
30 Cr-1 to 11 Mn	As cast	Up to 1650	"Better than straight-chromium iron"	23
30 Cr-11 to 15 Mn	As cast	Up to 1650	"Poorer than straight-chromium iron"	23
14 Mn	Hot-rolled	1000	43,400	9
14 Mn-1 W	Hot-rolled	1000	50,200	9
18 Cr-6 Mn-3 Si	Hot-rolled	1000	43,100	9
18 Cr-10 Mn-3 Si	Hot-rolled	1000	61,350	9
Standard 18-8	Hot-rolled	1000	54,600	9
Standard 18-8 + 3 Si	Hot-rolled	1000	81,300	9
17 Cr-8.9 Mn-2.2 W-0.4 C	——	930	96,000	47
17 Cr-8.9 Mn-2.2 W-0.4 C	——	1110	79,000	47
17 Cr-8.9 Mn-2.2 W-0.4 C	——	1300	57,000	47
18 Cr-9 Mn-3 W	Air-cooled from 1925° F.	1110	45,750	3
		1650	10,500	
18 Cr-8 Mn-5 Co	Air-cooled from 1925° F.	1110	50,000	3
		1650	19,000	
18 Cr-8 Mn-2 to 3 Mo	——	"High"	"As good as 18-8"	29
18 Cr-8 Mn-2 to 3 Mo plus Al or Si	——	"High"	"Poorer than 18-8"	29
18 Cr-9 Mn-2 Si-1 Al	——	1110 to 1830	"Not as good as 18-8"	40
4.5 Cr-20 Mn-2 Si-1 Al	——	1650	12,100	40
19 Cr-6 Mn-3.8 Si-1.8 Mo	——	"High"	"Valuable"	27

[a] *When only a comparative statement is given, it is because the numerical values were not given in the abstract and the original article was unavailable.*

Stainless steel sheets are being rough polished on the surface in a revolving belt machine, using suitable abrasives mixed with oil or grease. (Courtesy: United States Steel Corp.)



stituted for part of the manganese, has recently been given in a composite digest in METALS AND ALLOYS.[1]

High-Temperature Properties

One of the greatest advantages of the austenitic stainless steels over the ferritic chromium irons is that they retain their strength much better at high temperatures. This results in better load-carrying ability and better creep resistance. These properties are shown in Tables II and III and a summary of available information on the high-temperature properties of the manganese 18 and 8 steels and other similar alloys is given in Tables IV and V.

Comparison of Tables II and IV shows that whenever specific values are given (with the exception of data of Wolfson and Borzdika[47]), the chromium-manganese 18 and 8 alloys do not have as good high-temperature strengths as the standard 18 and 8 alloys even when other alloying elements (such as Mo, W, Co, Al, and Si) are added in an effort to improve high-temperature strength.

Without citing any supporting data, Krivobok[25] disputes this and says, "It is believed chromium-manganese austenitic steels have generally somewhat higher strength at high temperatures than chromium-nickel austenitic steels." Addition of molybdenum or tungsten improves high-temperature strength up to 982 deg. C. (1800 deg. F.). Properties of alloys of the general composition 15 to 16 Cr, 10 to 12 Mn, and 2 to 2.5 per cent W are superior at high temperatures to the chromium-nickel austenitic group with or without tungsten[25]. However, published results indicate that when nickel is not available, the addition of manganese to the chromium irons definitely improves their high-temperature strength, but decreases scaling resistance. The Russians, in particular, believe that the chromium-manganese alloys are as good for many purposes as the chromium-nickel alloys; they are using them extensively[6], as are the Germans.[39]

Comparison of Tables III and V shows that the published results on the creep strength of the manganese 18 and 8 alloys are too spotty for use in drawing definite conclusions. There is a fairly general agreement among all investigators that the chromium-manganese alloys, even when modified with other elements known to improve creep strength, do not have as good creep resistance as the chromium-nickel alloys.

Legat[28], who has apparently done considerable work with these alloys, is convinced that these chromium-manganese alloy steels have better creep strength in the range 500 to 700 deg. C. (930 to 1300 deg. F.) than chromium-nickel 18 and 8 plus molybdenum. He does not recommend addition of

TABLE V. *Creep Strength of Some Manganese 18 and 8 Alloys and Related Alloys*

Composition of alloy	Temp. deg. F.	Creep strength[a], p.s.i.	Basis for creep strength	Reference
14 Mn	1000	12,100	0.1% in 1000 hr.	9
14 Mn-1 W	1000	15,700	0.1% in 1000 hr.	9
18 Cr-10 Mn-3 Si	1000	11,250	0.1% in 1000 hr.	9
(Standard 18-8 + 3 Si)	1000	25,000	0.1% in 1000 hr.	9
17 Cr-8.9 Mn-2.2 W-0.4 C	930	28,500	10^{-6} per hour at 65 hours. A short-time creep test.	47
17 Cr-8.9 Mn-2.2 W-0.4 C	1110	20,600	10^{-6} per hour at 65 hours. A short-time creep test.	47
<15 Cr-15 Mn-0.25N	1100-1400	"Better than 25-20 or 20-14 Cr-Ni steels"	A short-time creep test.	42
<15 Cr-15 Mn plus Ti, Ta, or Cb	1100-1400		A short-time creep test.	42
<10 Cr-16.5 Mn-3.5 Si	1100-1300	"Same as Cr-Mn above but less than Cr-Mn-N."	A short-time creep test.	42
9 Cr-18 Mn-3.5 Si-1 Ni-0.1 C	1100	16,000	Unknown	39
9 Cr-18 Mn-3.5 Si-1 Ni-0.1 C	1400	6,000	Unknown	39
30 Cr-1 to 11 Mn (as cast)	Up to 1650	Poor	Unknown	23
30 Cr-11 to 15 Mn (as cast)	Up to 1650	Very poor	Unknown	23

[a] *When only a comparative statement is given, it is because the numerical values were not given in the abstract and the original article was unavailable.*

molybdenum, copper, tantalum, or columbium, although they improve creep strength above 700 deg. C. (1300 deg. F.) because of bad effects on toughness and tendency to cause intercrystalline fracture, but he does believe that addition of 0.1 to 0.3 per cent N to chromium-manganese steels will give the highest known creep resistance with no bad effects.

Wolfson and Borzdika,[47] on the basis of short-time creep tests, find that the addition of 2.2 per cent W to stainless steels containing 17 Cr, 8.9 Mn, and 0.4 per cent C produces an alloy which "requires 2 to 3 times the load to produce the same creep rate at any given temperature as in a 19 and 6 chromium-nickel stainless steel." However, their results are based on only 65-hr. creep tests and should be regarded accordingly. Substitution of some nickel for some of the manganese improves both high-temperature tensile strength and creep.[9]

(To be concluded)

References

[1] *Metals and Alloys,* Vol. 16, 1942, p. 960.

[2] E. C. Bain. "Functions of Alloying Elements in Steel," p. 10. American Society for Metals, Cleveland, 1939.

[3] F. M. Beckett. Yearbook Am. Iron & Steel Inst., p. 173. Am. Iron & Steel Inst., New York, 1930.

[4] F. M. Beckett, *Iron Age,* Vol. 125, 1930, pp. 1468-1470; *Metals and Alloys,* Vol. 2, 1931, p. 29.

[5] F. M. Beckett, *Metals Technology,* Vol. 5, 1938, T.P. 925.

[6] M. P. Brown, *Metal Progress,* Vol. 39, 1941, pp. 336-338.

[7] F. Brühl, *Arch. Eisenhüttenw.,* Vol. 10, 1936, pp. 243-255; *Metals and Alloys,* Vol. 8, 1937, p. 572.

[8] C. O. Burgess and W. D. Forgeng, *Metals Technology,* Vol. 5, 1938, T.P. 911.

[9] C. L. Clarke and A. E. White. *Trans. Am. Soc., Mech. Engrs.,* Vol. 53, 1931, Fuels Steam Power 53-14.

[10] R. S. Dean. "Electrolytic Manganese and Its Alloys," Progress Report of Metallurgical Div., U. S. Bureau of Mines, *Report of Investigations* No. 3580, Sept., 1941, p. 58.

[11] A. I. de Sy, *Rev. mét,* Vol. 36, 1939, page 389; *Metals and Alloys,* Vol. 11, 1940, p. 38.

[12] "Fine Steels," Allegheny Ludlum Steel Corp., Pittsburgh, 1937.

[13] Russell Franks, *Trans. Am. Soc. Metals,* Vol. 27, 1939, p. 513.

[14] K. Fuchs, *Metallwirtschaft,* Vol. 16, 1937, pp. 215-220; *Metals and Alloys,* Vol. 8, 1937, p. 514 R-5.

[15] L. C. Grimshaw, *Metals and Alloys,* Vol. 6, 1935, p. 264.

[16] M. A. Grossmann, *Steel,* Vol. 87, 1930, pp. 568-573; *Metals and Alloys,* Vol. 2, 1931, p. 167.

[17] Z. Gürzberg, W. A. Alexandrova and L. S. Geldermann, *Arch. Eisenhüttenw.,* Vol. 8, 1934, pp. 121-123; *Metals and Alloys,* Vol. 6, 1935, p. 38 L-3.

[18] W. Jellinghaus, *Stahl. u. Eisen,* Vol. 51, 1931, p. 918; Vol. 53, 1933, p. 357.

[19] V. V. Kendall, *Metals and Alloys,* Vol. 8, 1937, p. 313.

[20] F. F. Khimushin and O. I. Kurova, *Kachestvennaya Stal,* Vol. 4, 1936, pp. 16-25; *Metals and Alloys,* Vol. 8, 1937, p. 32 R-2.

[21] A. B. Kinzel, *Kachtestvennaya Stal,* Vol. 4, 1936, pp. 7-12; *Metals and Alloys,* Vol. 7, 1936, p. 604 L-6.

[22] A. B. Kinzel, *Metal Progress,* Vol. 29, 1936, pp. 3, 47.

[23] R. Kluke, *Arch. Eisenhüttenw.,* Vol. 11, 1938, pp. 615-618; *Metals and Alloys,* Vol. 9, 1938, p. 731 R-5.

[24] W. Köster, *Arch. Eisenhüttenw.,* 1933-34, pp. 687-688.

[25] V. N. Krivobok, *Metal Progress,* Vol. 34, 1938, p. 223.

[26] H. K. Legat, *Arch. Eisenhüttenw.,* Vol. 11, 1938, p. 371; *Metals and Alloys,* Vol. 9, 1938, p. 447 L-1.

[27] H. K. Legat, *Metallwirtschaft,* Vol. 17, 1938, pp. 509-513; *Metals and Alloys,* Vol. 9, 1938, p. 676.

[28] H. K. Legat, *Metal Progress,* Vol. 33, 1938, p. 284.

[29] L. Lieberman and P. Strelets, *Kachestvennaya Stal,* Vol. 5, 1937, pp. 11-21; *Metals and Alloys,* Vol. 9, 1938, p. 112 R-7.

[30] "Metals Handbook," American Society for Metals, Cleveland, 1939, p. 382.

[31] "Metals Handbook," American Society for Metals, Cleveland, 1939, pp. 539, 541.

[32] "Metals Handbook," American Society for Metals, Cleveland, 1939, p. 546.

[33] "Metals Handbook," American Society for Metals, Cleveland, 1939, p. 547.

[34] "Metals Handbook," American Society for Metals, Cleveland, 1939, p. 545.

[35] W. M. Mitchell, *Metals and Alloys,* Vol. 11, 1940, p. 121.

[36] J. H. G. Monypenny, *Metallurgia,* Vol. 17, 1938, pp. 93-96; *Metals and Alloys,* Vol. 9, 1938, p. 447 R-9.

[37] J. H. G. Monypenny, *Metal Progress,* Vol. 43, 1943, p. 241.

[38] John M. Parks, *Metals and Alloys,* Vol. 17, 1943, pp. 330-335, 539-543.

[39] G. Riedrich, *Metal Progress,* Vol. 42, 1942, p. 145.

[40] M. M. Romanoff and O. I. Ver, *Metallurg,* Vol. 9, 1934, pp. 43-52; *Metals and Alloys,* Vol. 7, 1936, p. 37 R-9.

[41] F. Schafmeister and R. Ergang, *Arch. Eisenhüttenw.,* Vol. 12, 1938-1939, pp. 507-510.

[42] M. Schmidt and W. Lamarche, *Korrosion u. Metallschutz,* Vol. 16, 1940, pp. 425, 527; *Metals and Alloys,* Vol. 13, 1941, p. 805.

[43] Frank T. Sisco, *Metals and Alloys,* Vol. 15, 1942, p. 45.

[44] J. R. Suman, *Mining and Met.,* Vol. 23, 1942, p. 9.

[45] H. H. Uhlig, *Trans. Am. Soc. for Metals,* Vol. 30, 1942, p. 947.

[46] F. Wever, *Stahl u. Eisen,* Vol. 15, 1931, p. 651.

[47] S. I. Wolfson and A. M. Borzdika, *Metals and Alloys,* Vol. 8, 1937, p. 294.

Low Temperature Joining

for Production and Repair

by **ROBERT S. BURPO, JR.**
Associate Editor (on leave with the Armed Forces)

Much curiosity and considerable skepticism have attended the introduction to the American market of a series of so-called "low-temperature welding" (Castolin Eutectic) alloys in the last few years. Certain of these weld-rod materials are claimed to produce joints as strong as conventional fusion welding, but at temperatures down in the brazing range where distortion and unwanted "tempering" can be minimized. METALS AND ALLOYS *therefore delegated Mr. Burpo to investigate these materials by obtaining factual data, experience records, working methods and opinions of their utility directly from plants that have used them long enough to speak with authority. This article is his report to metal-industries engineers on these users' experiences.—The Editors.*

WELDING IS ACCOMPLISHED by the use of enough heat to cause fusion of the rod with the materials being joined. The higher the temperature necessary to make the weld, the greater are the stresses set up in the parts being joined; this leads to distortion. If lower temperatures must be used (to avoid distortion), then, as far as iron and steel are concerned, only brazed joints can be made. These low-temperature brazed joints are usually much weaker than the parent metal. Here, then, are the alternative methods when joining iron and steel:

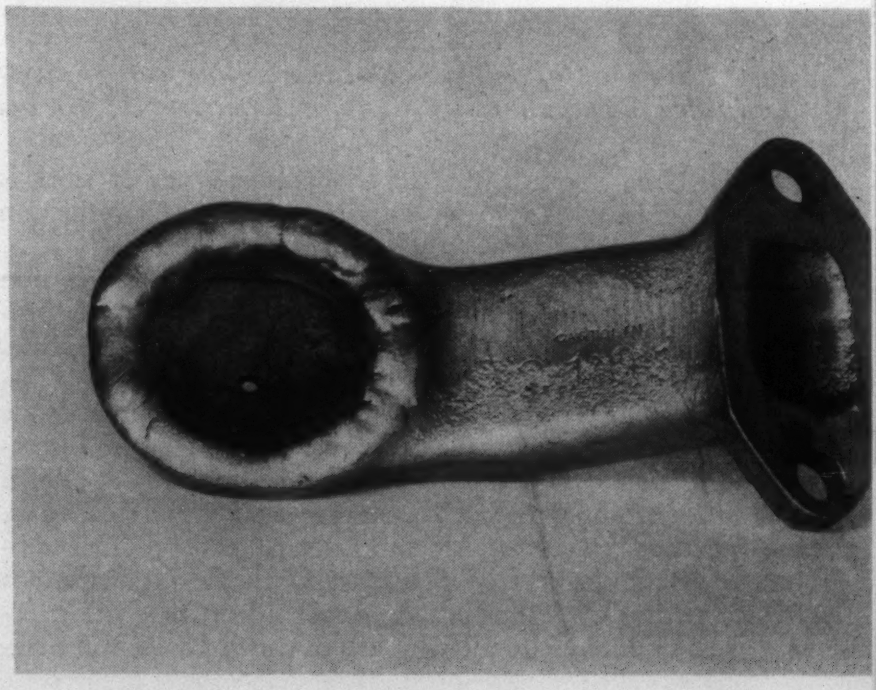
1. A strong weld made at a high temperature
    - (a) the higher the temperature, the greater are the stresses produced by welding
    - (b) the higher the temperature, the greater is the softening or tempering effect if the steel has been hardened
2. A low temperature joint
    - (a) stresses are quite low (as the brazing temperature is low)
    - (b) little softening of hardened steel occurs
    - (c) the joint is usually lacking in physical properties (compared to the parent metal)

To remedy this situation, a series of low melting-point brazing alloys has been developed. One member of this series, in particular, is of interest: It not only is a low melting-point material, but the joint made with this rod has very favorable physical properties, and its flow temperature is so low that hardened high-speed steel parts can be joined with only one point Rockwell C loss of hardness. Some of the other items in this series of proprietary brazing rods include some very low melting materials and rods that will match the color of the parent metal. The trade name of these alloys is "Castolin Eutectic" and the line is manufactured by the Eutectic Welding Alloys Co., 40 Worth St., New York City.

Fields of Application

As these products are quite new in the industrial field, their applications are somewhat limited; however, these are being broadened rapidly. Certain features of their use should be stressed at this point:

Fig. 1. A typical repair-welding job—an undersized aluminum casting built up with Castolin Eutectic alloy No. 210.



Each rod functions best with a particular flux, which means that an assortment of fluxes must be kept on hand if any variety of rods are employed. Brazing with Eutectic Welding products also requires somewhat different techniques than those used with other rods, but these are easily learned. Some of the items of the Castolin Eutectic line compete directly with brazing materials already on the market. Others are in a class by themselves in that they are somewhat different than products already on the market.

Following are some notes regarding one or two of the more unique metal-joining alloys that have been applied with considerable success to these types of industrial work. These three types of work are:

(1) the production joining of small parts
(2) repairing casting defects (such as building up bosses and increasing allowances for machining in critical spots) and also for repairing wrought parts
(3) the repairing of broken tools and cutters

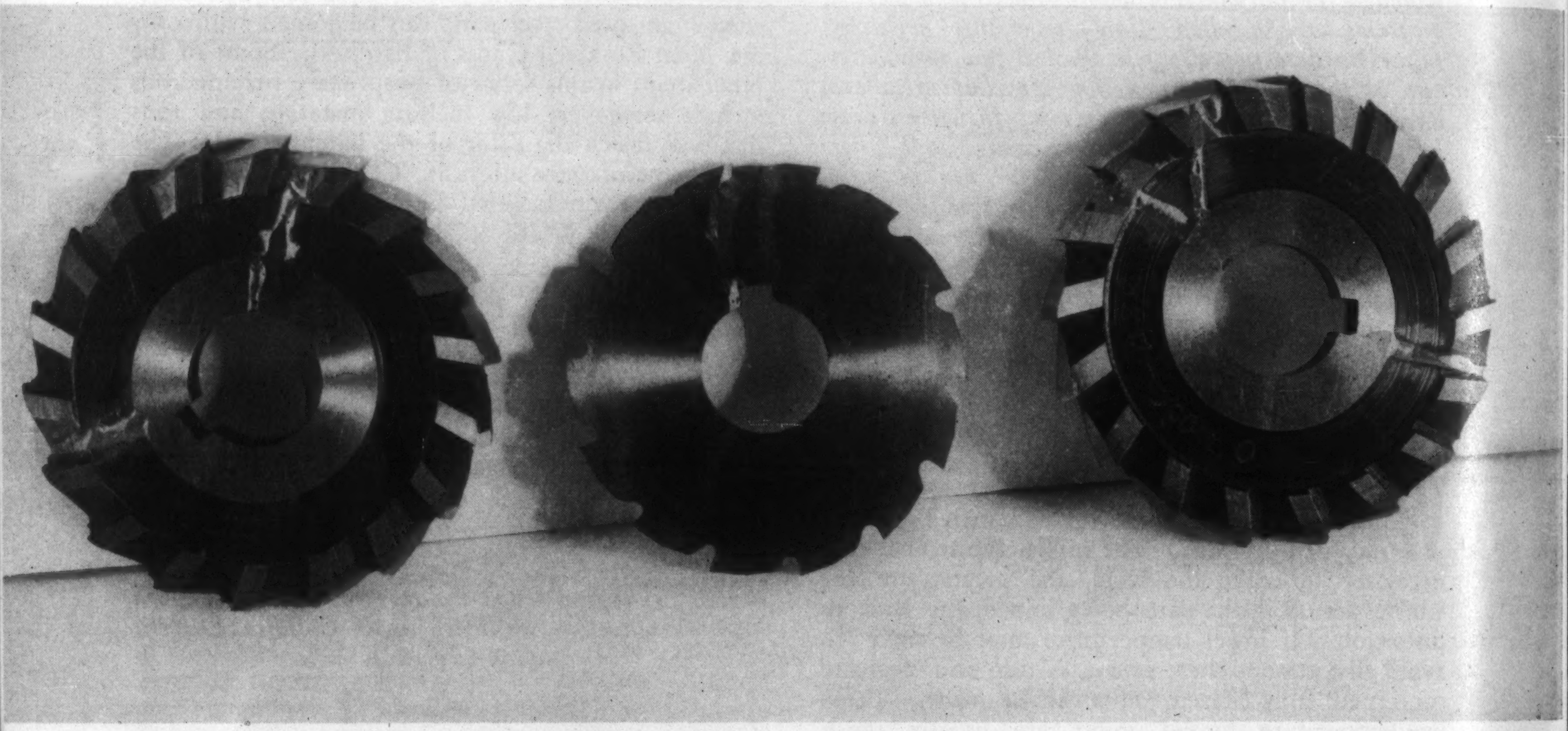


Fig. 2. The set of high speed steel milling cutters shown here was broken when new, then repaired by Bell Aircraft's Ordnance Division, using Castolin Eutectic No. 16 rod, and was used thereafter on stainless steel until undersize.

Users' experience with these three types of work is described below; the important field of production joining will be discussed last of all.

When using these alloys, the rod, in combination with the special flux used for each type of rod, produces a metallic joint at a very low temperature. The mechanism of this low temperature joining process is not generally understood, but the claim is made that the joint is of eutectoid or quasi-eutectoid composition. The relatively low temperatures at which these rod-parent metal eutectoid joints are formed is, perhaps, their most valuable property. This important characteristic is linked with the high-strength features of certain of the alloys and makes the process of interest to all who are concerned with the brazing and welding of small parts. Of somewhat secondary importance is the fact that many patches and joints made with Castolin Eutectic rods can be matched with the parent metal.

Welding Aluminum Castings

The experiences gained in the salvaging of defective sand cast aluminum and magnesium alloy parts by the Todd Co., of Rochester, N. Y., indicate that the ease of welding delicate castings (where high temperatures and the consequent distortion would be intolerable) and color matching between the joint and parent metal are of primary importance. Here in the machine division of the Todd Co., the well-known checkwriting equipment and accounting machines are made. In connection with his work in the machining and fabrication of sand cast and wrought aluminum alloy and sand cast magnesium alloy parts, Fred J. Myers, general foreman, has developed processes for the reclamation of many production parts that otherwise would be scrapped.

At the Todd Co. there are a number of light alloy castings used, and the first operation performed on them is cold straightening. Some of these castings crack when straightened. Another point at which rejections are liable to occur is after the machining operations. If there have been certain minor defects in casting or placing the cores so that the part has insufficient allowance for machining, or if a boss that is to contain a tapped hole needs building up, these can be corrected by welding, as will be described below.

More specifically, the treatment of a typical sand cast aluminum-alloy part will be described. This part is called a base and requires straightening; any cracks resulting from this operation are immediately repaired using Eutectic Welding Alloy No. 210 (an aluminum-base alloy, bonding temperature 950 deg. F.) and the corresponding special flux applied with an oxyacetylene torch.

This type of casting is of variable section (ranging from about 1/16 in. to 5/16 in.) and preheating is necessary before the repairing operation is started; total weight of the rough casting is about ½ lb. Generally, no difficulty in repairing cracks is encountered, although not every casting can be saved. Also, after machining, some of these parts need repairs to thin sections where break-throughs have occurred, or where insufficient stock was allowed on a boss for finishing or for drilling and tapping.

The only preparation made for welding is the application of flux (after preheating). Ample weld metal is deposited, and any excess is later removed by machining. The machinability of this type of weld has always been substantially the same as that of the parent metal. The welding of castings made from secondary aluminum has been more difficult than those castings made with the virgin metal.

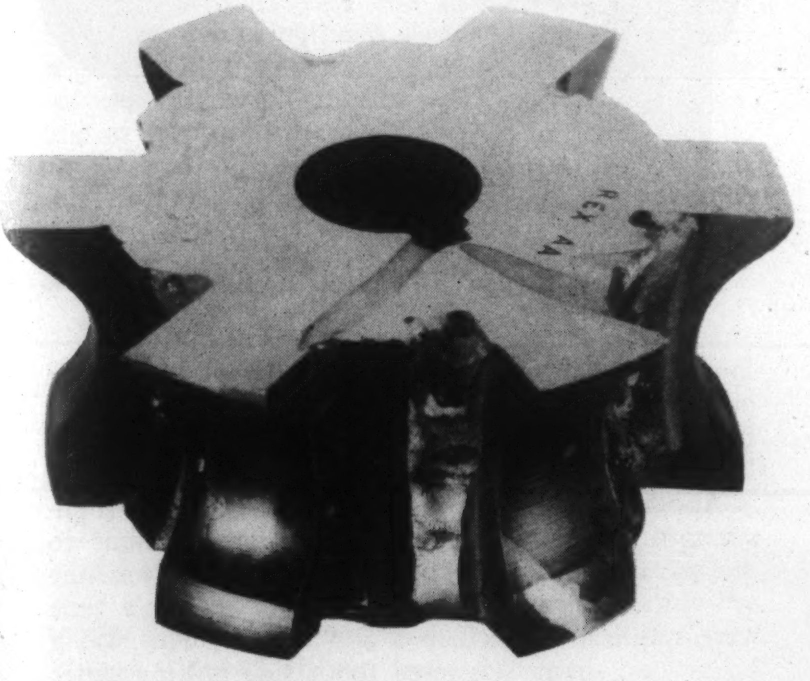


Fig. 3. Milling cutter with the shank welded on by the Castolin Eutectic process, using No. 16 alloy.

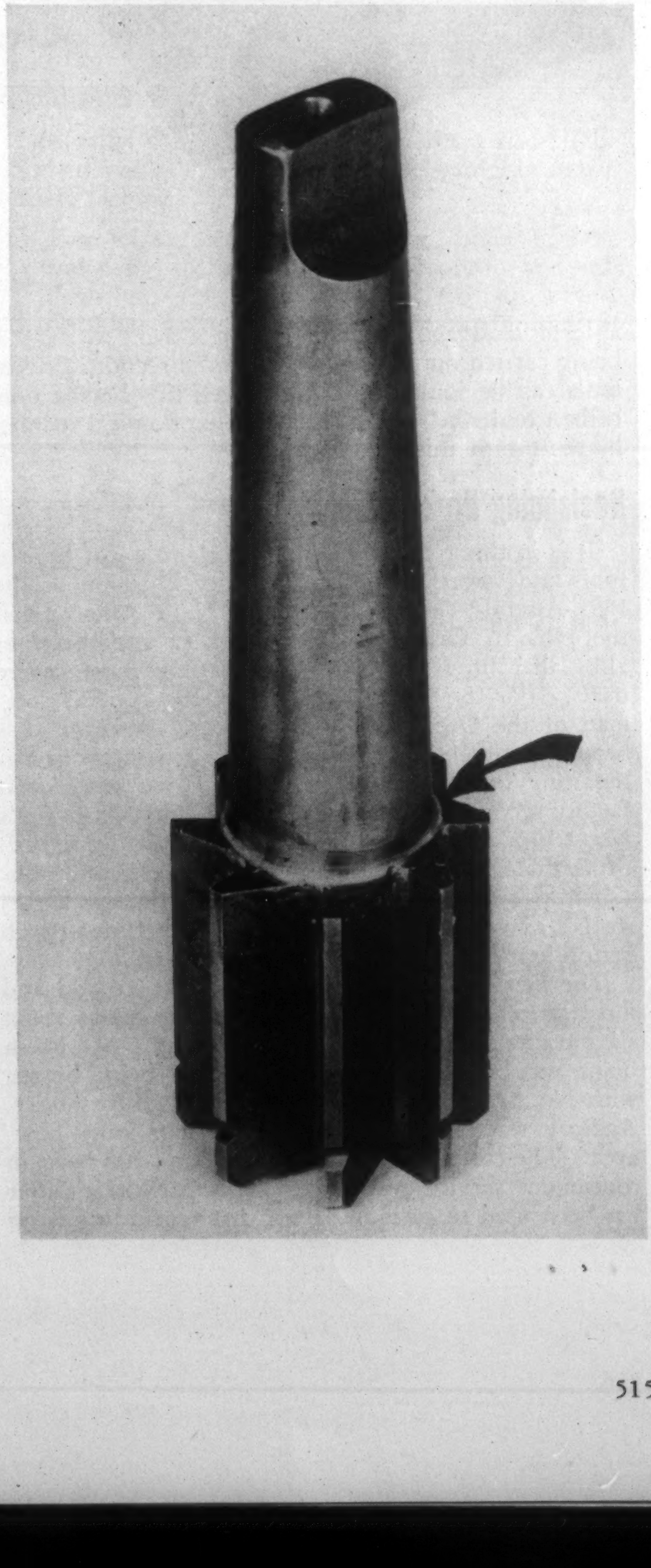
Since these particular parts (bases) are rigidly inspected, and the dimensional tolerances are fairly close (±0.001), practically no distortion can be tolerated, and very little actually occurs.

Another part on which a Castolin Eutectic rod is used is a cover made of No. 11 gage sheet aluminum, formed and spotwelded. No cracks between the sheets are permitted at the joints, so when these occur, the space is filled by using the No. 190 rod (aluminum-base alloy) and flux.

A similar procedure is followed with the control frame, a sand cast magnesium alloy part (AMS 4422A, heat treated to 50 Brinell). If it is necessary to repair any cracks or build up any bosses, the No. 1900 rod (contains over 90 percent Mg) and flux are used.

This practice for the salvage and repair of magnesium castings was developed by Fred J. Myers to meet the needs of the Todd Co. At the time when he started his investigation of the repairing processes for magnesium castings, little or no data were available. In addition to developing techniques for the successful welding of magnesium castings, a profit-

Fig. 4. This form cutter broke when running on its fourth piece. It was then repaired at Bell with the No. 16 alloy and has been in service more than 7 months without any trouble.



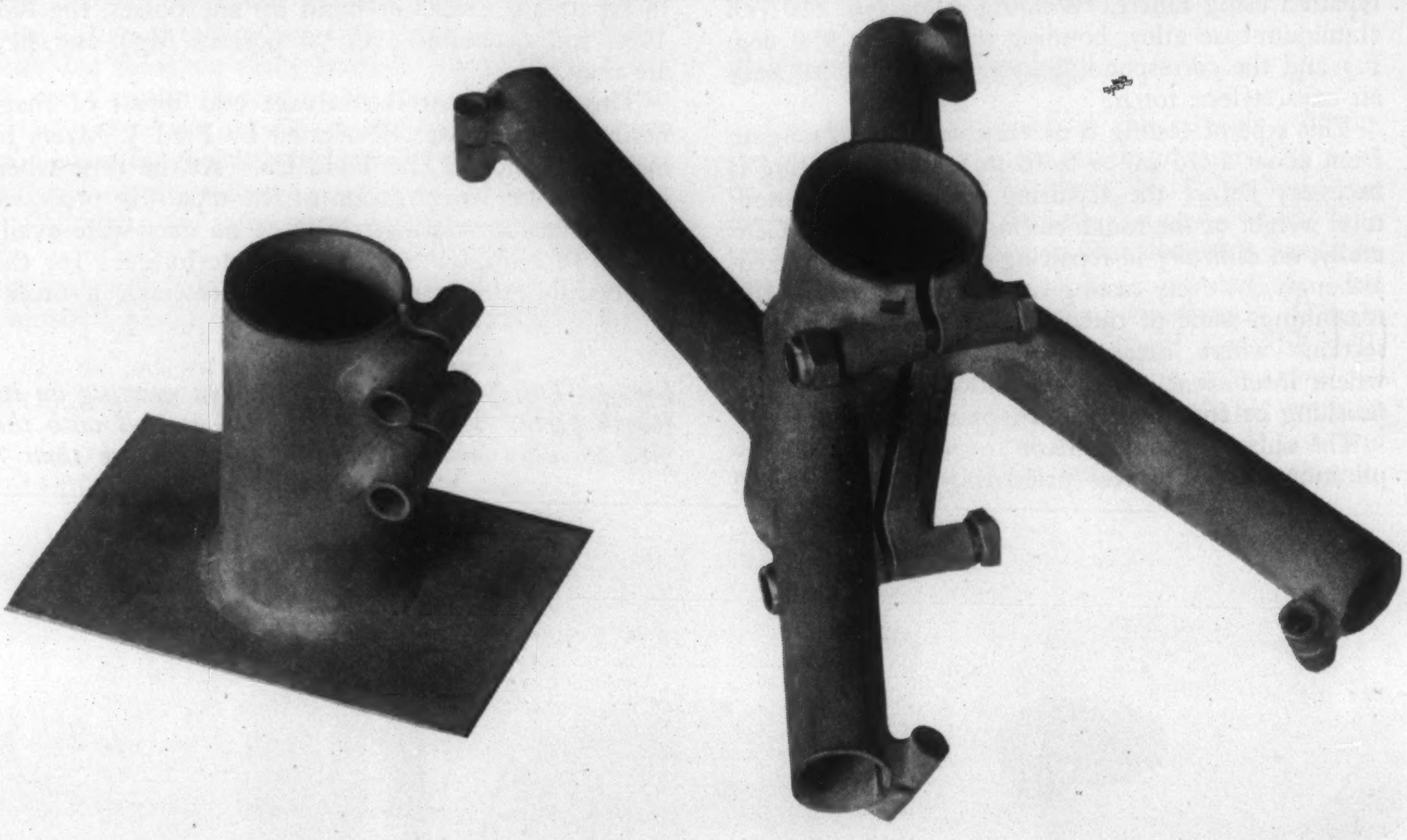


Fig. 5. Two tubular steel assemblies employed in aircraft construction that have been welded with Castolin Eutectic alloy No. 16.

able tool salvage program (using a No. 16 rod) is being carried out under Mr. Myers' direction. Broken tools can be joined, and high-speed tips brazed onto carbon tool steel shanks in a very economical manner by the use of this No. 16 rod.

Reclaiming Broken Tools

It is in this type of work, the reclaiming of broken tools and cutters, that the Ordnance Division of the Bell Aircraft Corp. (at Buffalo, N. Y.) has given the No. 16 Castolin Eutectic rod (a nickel-copper alloy that binds at 1300 deg. F.) its most severe trials. For the past 10 or 12 yrs. the general foreman of the Ordnance Division, C. C. Stockton, has been experimenting with materials and methods for repairing broken milling cutters. None gave satisfactory service until the Eutectic Welding Alloys Co.'s No. 16 rod was used. Tools used in machining ordnance material must stand up under severe conditions (such as cutting heat-treated chromium-molybdenum steels) as well as withstanding the sometimes rough handling of "green" machine operators.

The first use of Castolin Eutectic No. 16 rod and flux for repairing a milling cutter was made about six months ago. A formed cutter about 1 x 3 in. in diam. was broken into two pieces; after being brazed with No. 16 rod and flux, it was returned to service. Again it was broken, not at the previous joint, however. The cutter was again repaired and has been in continuous service ever since. This particular cutter has been used to such an extent that regrinding is no longer feasible because it is so badly worn from numerous sharpenings. This was the first successful repairing of a high-speed steel cutter in the Ordnance Division of this company.

Another example of the application of high-strength low-flow-temperature brazing technique to the salvaging of high-speed milling cutters was one in which approximately 35 min. of a man's time were required to reclaim a $45 cutter. This was a ⅝ x 7 in. diam. staggered tooth side milling cutter that had been broken through the keyway into two sections.

We may take as typical of the methods employed by the Bell Aircraft Corp. Ordnance Division the procedure followed in the brazing of a metal slitting saw (⅛ x 4 in. diam.) that had been cracked in service. First, a shallow groove is ground over the cracks on both sides of the cutter, then these grooves are washed with carbon tetrachloride, and flux (in paste form) is brushed into the grooves. Meanwhile, a cast iron block (to which the cutter could be clamped during the brazing operation) is preheated to 700 to 800 deg. F.

The cutter is then carefully clamped on the plate and, after levelling, more flux is applied in the grooves; then the grooves are filled in with the No. 16 rod material. When this is completed, the clamps are released and the cutter turned over on the plate; the brazing on the other side is then completed and the cutter is buried in lime and allowed to cool slowly for about 24 hrs. before re-sharpening.

The following description of the steps used when brazing a broken ½ x 6-in. diam. staggered tooth side milling cutter is similar to those given above in many ways. As this cutter was broken into two pieces, the edges of the breaks were chamfered on both sides so that about 1/16 in. width of surface would abut when joined. This narrowing of the width of contact permitted the deposition of an adequate quantity of brazing material as well as making the lining up of the two sections fairly simple. The joints were cleaned and fluxed, and the pieces were clamped on the cast iron plate in the same manner as with the saw. However, this side milling cutter, being of much heavier section than the saw, did not require preheating (if there were residual heat in the block from previous jobs, the cutter would be warmed sufficiently.) After brazing both sides of the joints, the cutter was slow-cooled in lime.

In all of this repairing of broken and cracked high-speed steel cutters, the damaged cutters are taken directly from service, the edges to be joined are chamfered, cleaned and brazed, and the cutter is slow cooled as outlined above. Then the cutter is re-ground on a tool and cutter grinder and is ready for use. By employing these techniques, the distortion of repaired cutters usually is less than 0.001 in. on the OD. The reduction in hardness next to the joint is usually limited to 1 point Rockwell C.

Joining Production Ordnance Parts

Production ordnance parts have been successfully joined by use of Castolin Eutectic rods and have passed rigid Army and Navy tests. One of these parts is a link chute, made of a formed piece of 18 and 8 stainless steel (No. 20 gage B&S) and two lugs each about 1/16 in. thick, also made of stainless steel. These three pieces were formerly joined by carbon arc welding; now they are brazed with a No. 16 rod and oxyacetylene torch. The former and present sequence of operations for fabricating this part are summarized:

Fabrication of Stainless Steel Link Chute

Operations in former method	Present operations
1. Place 3 pieces in fixture	1. Place 3 pieces in fixture
2. Tack weld lugs to sheet stock	2. Braze
3. Remove part from fixture	3. Remove part from fixture
4. Finish weld	4. Rinse in hot water and pickle
5. Sand blast	
(Time for operations 1 through 4: 3 min.)	(Time for operations 1 through 3: 1½ min.)

Similarly, the steps in fabricating a support, which is made of elliptical chromium-molybdenum SAE 4130 steel tubing having two threaded lugs attached to one side and two adapters, attached one at each end, are:

Fabricating a 4130 Steel Support

Former method	Present method
1. Place 5 pieces in fixture	1. Place 5 pieces in fixture
2. Weld 2 lugs and 2 adapters to tubing	2. Braze 2 lugs and 2 adapters to tubing
3. Remove from fixture	3. Remove from fixture
4. Normalize	4. Rinse in hot water and pickle
5. Sand blast	5. Clean and electroplate
6. Clean and electroplate	
Time for operations 1 through 3 (using carbon arc): 20 min.	Time for operations 1 through 3: (using No. 16 rod and oxyacetylene torch): 3 min.

In the case of the link chute, the fabricating time is cut in half and the number of operations is reduced from 6 to 5, with no reduction in quality. The support that formerly was fabricated in 20 min. now is finished in 3 min., reducing the time to 1/6th its former value; also, normalizing and sand blasting equipments are freed for other uses.

Similarly, a machine gun sight has had its assembly time cut in half using the No. 16 rod as compared with the original silver soldering method.

Conclusions

Generally, the properties of the No. 16 rod (the nickel-copper alloy) that have made it highly useful at these factories are:

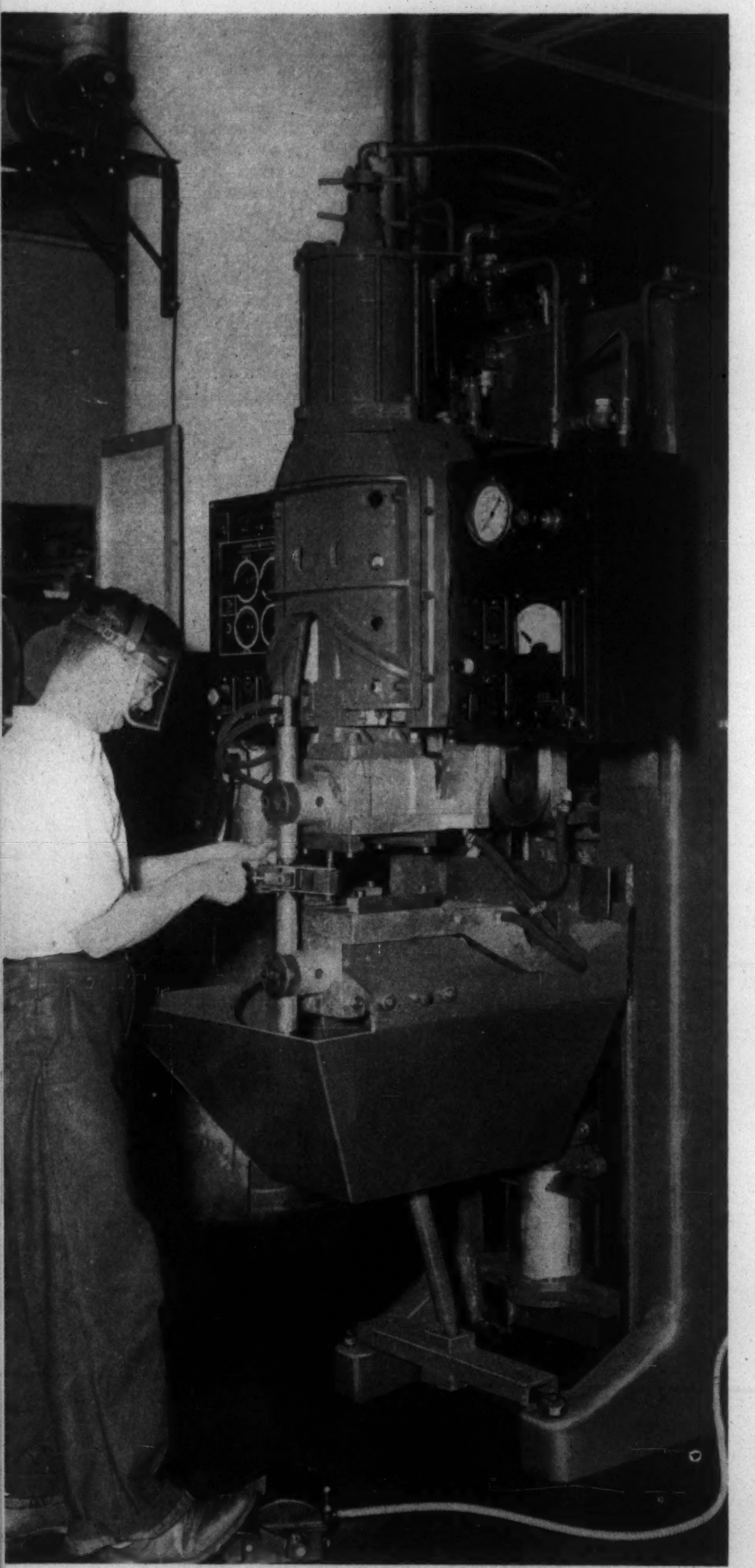
(1) Ease of application—the molten brazing material seems to have a very high mobility and will flow into very narrow spaces, making a very complete joint with a minimum expenditure of time and rod.

(2) The strength of the brazed joint. (As in the case of the repaired milling cutters described above, the strength of the joint is at least equal to that of the parent metal; tests made on the previously mentioned support show that under a tension of 159,000 lbs. per sq. in., the steel gave way, leaving the brazed joints undamaged.)

(3) Using the special flux furnished with the No. 16 rod, the workman is furnished with an indicator telling him when to apply his rod, for this flux takes on a peculiar wet appearance when the joint is at the proper flow temperature.

(4) The No. 16 rod has a number of uses:
   (a) Joining steel parts (chromium-molybdenum, high-speed and stainless steel jobs were described above).
   (b) It can be used to braze carbide tips onto tool shanks and into milling cutters, etc.

Although the exact compositions of these patented alloys cannot as yet be published, the information presented in this article is an attempt to answer the currently more important question as to the nature, whereabouts and practical aspects of some outstanding successful application of the Castolin Eutectic process and materials.



Press type spot welder. A modern type machine with electronic current controls and foot pedal switch. (Courtesy: General Electric Co.)

Resistance Welding

—No. 1: Processes and Machines

The war has brought tremendously increased application and recognition of resistance welding and this joining method can be expected to be a major factor in postwar engineering planning. In this issue we begin a series of articles intended to bring both production and design men up-to-date on resistance welding. This first article discusses resistance welding in general, outlines the various spot, seam and butt welding processes in use and describes some of the modern machines that are now available. Other articles on controls, electrodes, supplementary operations, etc. will follow. —*The Editors*

By KENNETH ROSE
Engineering Editor

FOR MANY YEARS engineers have been developing processes for joining metals, not by separate fasteners such as rivets or bolts, but by actually fusing together the metals themselves. The methods of the blacksmith shop were not widely applicable, and were slow and costly at best. Gas welding — portable, quick, applicable to many metals, and cheap — was a real engineering answer to the problem. Arc welding was even faster. Both processes continue to fill a place in industry in which they are unchallenged.

Resistance welding is a solution to this processing problem which, because it has been made to fit into modern production systems, has become one of the foremost metal joining methods. It permits the joining by fusion of two or more metal surfaces, rapidly and securely, without the addition of rod material, and often without the necessity for cleaning the work afterwards. The many adaptations possible have given rise to branch types of the process, until today we have spot welding, flash or upset-butt welding, seam welding, projection welding, percussion welding, and other types less clearly defined.

The essentially distinguishing feature of resistance welding is that the heat necessary to fuse the metals is produced by the passage of very large electric currents through the metals. In the case of flash welding the heat is generated in part in an arc between the two surfaces to be joined.

Current Requirements

Since the resistance of the metal to the passage of the current generates the heat, very high currents are necessary. It is at once apparent that the electrical resistance of the metal to be welded, and its heat conductivity, are of prime importance in fixing the welding procedure. Metals having low electrical resistance, such as aluminum, copper, and silver, require enormous currents to generate the necessary heat, while metals having good heat conductance tend to dissipate the heat through the work rather than to keep it concentrated at the region of the weld. For this reason silver and copper are very difficult to weld by purely resistance methods. Aluminum can be welded with little difficulty, although high currents are required, while steel, Monel metal, silicon bronze, and "nickel silver" require less current.

Generation of heat by electrical resistance in a conductor follows Joule's Law, which is given in the following equation:

$$H = 0.24\ I^2RT$$

in which H is the heat generated in calories
I is the current in amperes
R is the resistance in ohms
T is the time in seconds

The heat generated will vary as the square of the current used, or directly as the time of application of this current. The value of using high amperages is therefore apparent. Unfortunately, too high current values tend to mark or "burn" the work, and so a practical limitation is imposed. The resistance in the above formula is a composite of the specific resistance of the work, the contact resistance from the electrodes to the work, and the contact resistance between the two or more pieces to be welded. Contact resistances will vary with the shape of the electrodes, the condition (or shape, in projection welding) of the faying surfaces, and the pressure applied.

To avoid loss of heat from the immediate weld zone during current flow both by radiation and conduction, the welding time is shortened as much as possible. The welding engineer is here faced with the problem of adjusting values for the current and time cycle so that the work will be heated to fusion at the point to be welded, so quickly that the generated heat is not lost by conduction through the body of the work, nor by radiation, nor by conduction through the contacting electrodes, and at the same time without using current values so high that marking results, or electrodes tend to stick. The settings are determined by trial and error, in the light of experience.

Spot Welding

Spot welding is the most versatile of the resistance welding processes. In essence, it consists of pressing two or more metal surfaces between electrodes, and passing the welding current. The inner, or faying, surfaces fuse together, the fusion zone being sharply localized by the pressure applied. Machines are of two general types — portable and pedestal, the former for welding pieces which cannot be brought to or placed in the fixed-location welder, the latter as the standard production machine.

Portable Spot Welders

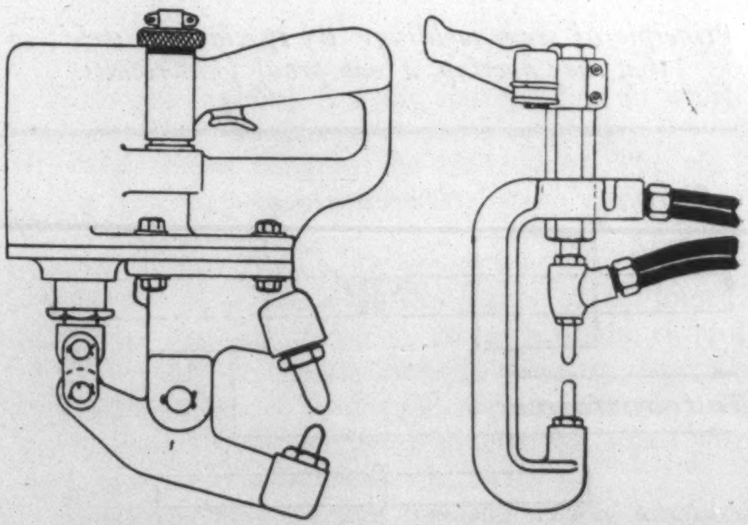
The portable welding "gun" permits spot welding of large pieces of work, or of pieces placed together in a fixture, or of work which cannot be brought to the machine, as of parts on an assembly line. Steel up to $1/8$ in. in thickness or its equivalent is usually regarded as maximum capacity. Either pneumatic or hydraulic pressure may be applied to the electrodes. The transformer, current and pressure controls, and cooling water are located in a unit connected to the gun by cables and hose lines carrying the current, compressed air or oil, and, usually, cooling water. The leads which must carry the high currents required are often water-cooled.

Spot welders of this type are especially useful in tacking assemblies of metal sheets or stampings. Bar welders and pull welders are specialized types of portable welding machines.

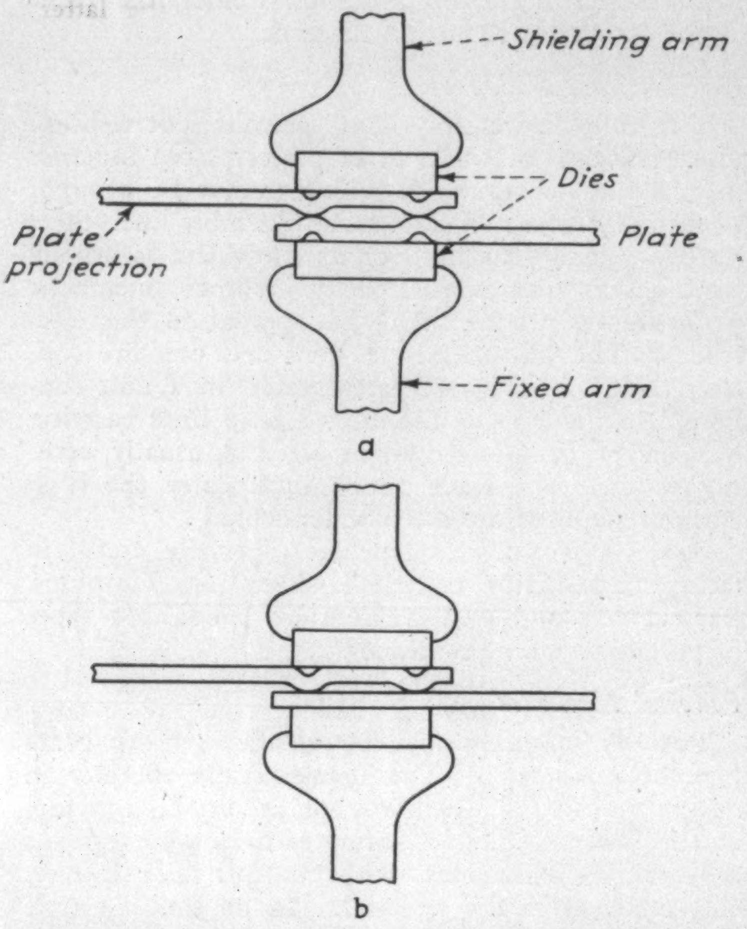
Pedestal Machines

Pedestal machines may be of the walking beam type or press type. The former is the simpler in design, consisting essentially of an upper, moving, and a lower, stationary, arm, each holding one of the welding electrodes, with controls, transformer, etc., attached to the pedestal. In its simplest type electrode pressure is obtained through a foot treadle. The capacity of such a machine is necessarily limited. Larger machines use pneumatic or hydraulic pressure, or obtain pressure through a motor-operated cam. Capacities are similar to those of the portable welding machines.

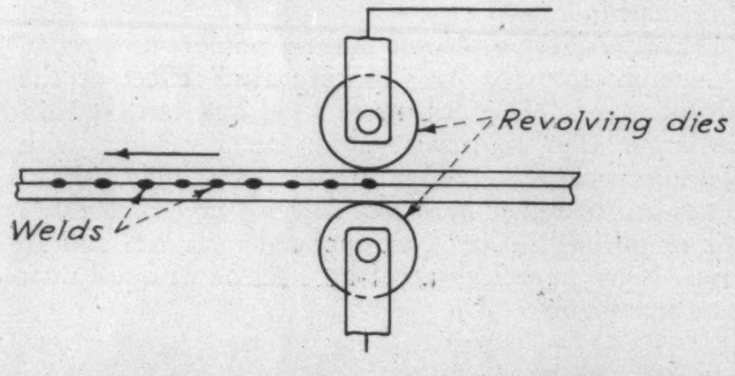
Press welders substitute sliding holders moving in a straight line for the "rocking arm" effect of the former type. They are more rigid and can be built in larger sizes than the walking beam welders, with work capacities stepping up correspondingly. Pressures are obtained by motor-driven cam, compressed air or oil, with some foot-operated machines still in use. Usual capacities are 1-in. steel or its equivalent as a maximum.



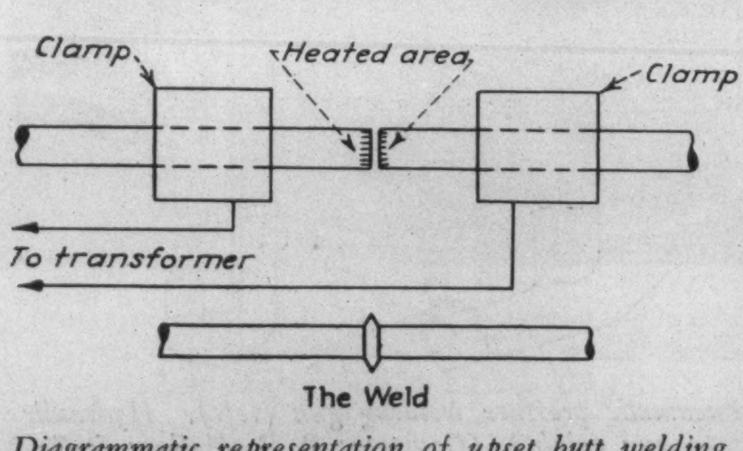
Pneumatic pressure welding gun (left). Hydraulic type gun (right). (Courtesy: P. R. Mallory & Co., Inc.)


Shielding arm
Dies
Plate projection
Plate
Fixed arm
a
b

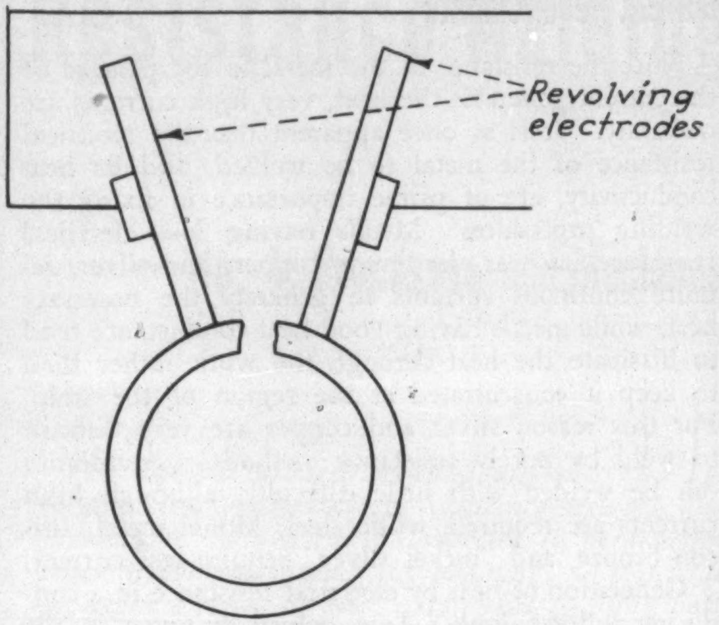
Production welding. (a) Projections in both plates. (b) Projections on upper plate only.


Revolving dies
Welds

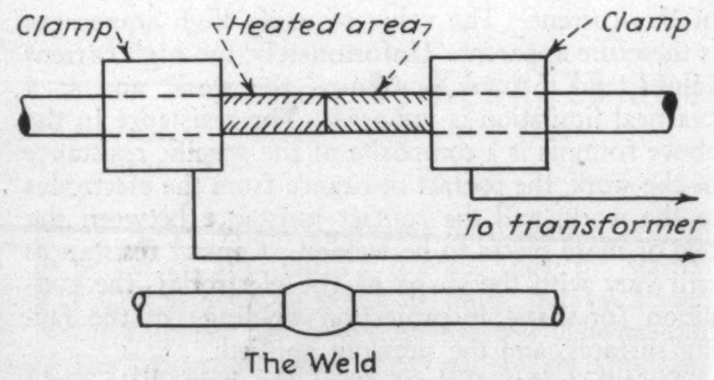
Principle of seam welding. By spacing the welds so that they overlap, a leak-proof joint results.


Clamp
Heated area
Clamp
To transformer
The Weld

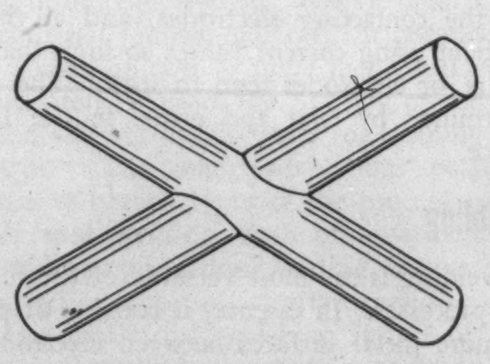
Diagrammatic representation of upset butt welding. A substantial upsetting of the work takes place.


Revolving electrodes

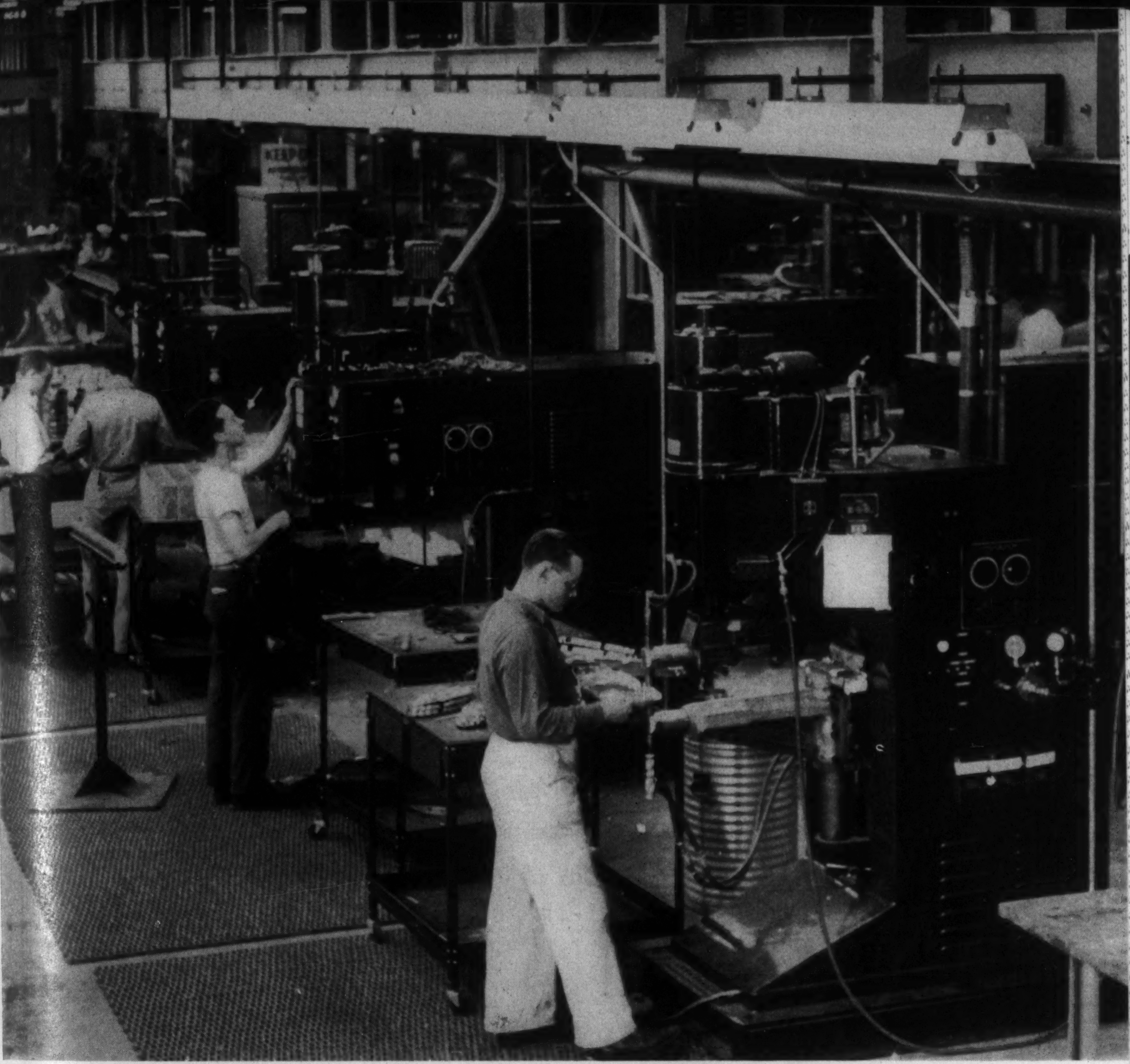
A butt seam, used for making welded tubing.


Clamp
Heated area
Clamp
To transformer
The Weld

Flash-butt process. Heating and upsetting are more sharply localized.



Crosswire welding. The crossed wires themselves localize the effect of the current.



Spot welders in a large aircraft plant. Controls are located on this balcony, illustrating the tendency to decentralize this equipment. The machines are operated directly from a 2300-volt supply. (Courtesy General Electric Co.)

The moving electrode holder, or ram, may be rectangular, as in the slide type of machine, or cylindrical (quill type). It is an indication of the adaptability of spot welding that the machines can be used to produce a seam by closely spaced spot welds (lace welding), or as projection welders by replacing the spot welding electrodes by projection dies attached to the upper and lower platens.

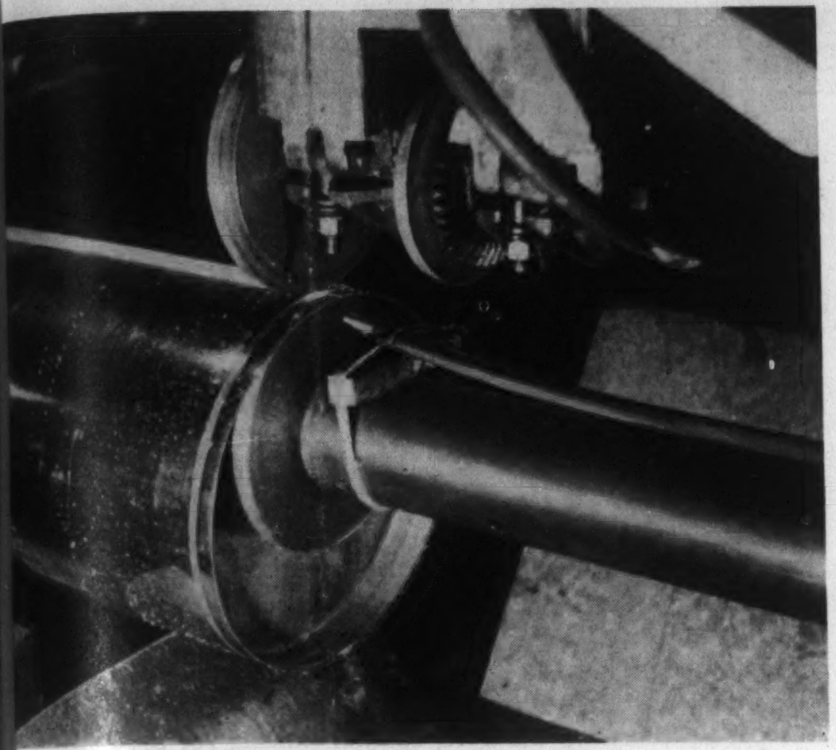
Production may be increased in some spot welding jobs by the use of multiple-electrode machines, built or adapted to meet the requirements of a specific operation. A number of electrodes make contact, either in predetermined order or simultaneously, with the work, and the current is applied to the electrodes successively by a timing device. The machine is usually automatic in nature, the sequence of applying pressures and currents being carried out by electronic or mechanical control. The job is thus completed in one operation.

Projection Method

Projection welding is really spot welding in which the current application is localized by projections on the work rather than by the electrodes. The electrodes in this case become broad dies, designed to transmit current and pressure uniformly to the outer surfaces of the work. The projections may be made on either one or both of the pieces to be joined. Crosswire welding, in which the path of the current is determined by contacts between wires, is a specialized application of projection welding, much used for making wire or rod mesh or gratings, small wire gadgets, electric wire terminals, etc.

Machines for projection welding closely resemble press type spot welders — in fact, the spot welders are frequently used for light duty projection welders. Rigidity of the machine arms, to preserve perfect alignment of work and dies, and low friction in the

Time reduced to one-fifth. By using resistance welds instead of arc welding in switchgear assembly, considerable savings in time were effected. (Courtesy: General Electric Co.)



Brazing with a seam welder. Joining by this process seals the circular seam in the copper can without annealing the work-hardened metal. (Courtesy: Thomson-Gibb Electric Welding Co.)

ram and its driving cylinders, to permit quick take-up as the work becomes plastic, are two necessary factors in projection welding machines. Maximum work size is about 1 in. thickness of steel or its equivalent, although the size of the projections can be of more importance than the thickness of the plate.

Seam Welding

When a continuous or intermittent weld is to be made between two edges or surfaces, a slightly different type of machine is used. The circular seam welder, designed to weld the end seams in circular work, possesses two rotating electrodes or wheels to localize the current; the longitudinal seam welder for straight seams usually has two wheels, but may have only one rotating electrode, with an anvil replacing the lower one. A combination type can be used for both seams by swiveling the upper head 90 deg. A butt seam welder is designed to produce a continuous longitudinal butt weld, as in pipe.

Pressure is usually pneumatic. The electrodes serve an additional purpose in the seam welder in that they feed the work. The drives which rotate the welding wheels are variable speed, and may drive either the upper or lower wheel, or both, through gears or rollers. Current may be applied continuously, but this tends to overheat the work ahead of the electrodes, so that a pulsating current is generally used. The effect is to form the seam by a series of overlapping spot welds. Adjustment of current pulsations, made electronically, and electrode speed can be such as to make a series of widely spaced tack welds or a gas-tight continuous seam. The seam is usually made under a water spray to hold work distortion to a minimum, and to prevent electrode overheating.

Seam welders are also used for brazing of (usually) non-ferrous metals when it is desired to avoid the annealing effect of the gas torch. In this case the brazing metal is fed into the seam in ribbon form, and the bond is made while sharply localizing the heat of the brazing current.

Butt Welding

Practically all of the types of resistance welding described might be considered as forge welding, since the application of pressure to consolidate the fused metal is an essential part of each process. In the case of butt welding this is even more the fact. With both the upset-butt and flash-butt processes sufficient pressure is applied to produce a definite and calculated upsetting of the work at the weld. Taking advantage of this upsetting, the upset butt welding machine can be used as a forging machine by using bar stock or pipe in one piece between the dies.

In both butt welding processes the work is clamped between dies which act as the electrodes. Bars, rods, or pieces of similar character which can be held in the jaws of the electrodes are the usual material for butt welding, although the use of special dies has widened this field considerably. The feature which distinguishes between the two processes is that in upset-butt welding the current is applied after the butts to be welded have been brought into contact with each other, while in the flash process current is applied as soon as the pieces have been properly clamped. This latter arrangement causes an arc, or rather many small arcs, to leap the gap between the butts as they are being brought together, with consequent "burning-off" of irregularities of the metal faces.

Opportunity for welding metals of dissimilar character is afforded by the flash-butt process. Metals or alloys which could not be satisfactorily fused together in any other way can be joined with little difficulty. The process is extremely adaptable so far as size range is concerned also, being used for welding steel strip in continuous strip mills and for wires for lamp filaments. The pressure applied may be exerted by hand, with proper leverage provided, by compressed air, by hydraulic pump, or by a motor-driven cam.

In the manufacture of heavy gratings of iron or steel, the bars are frequently cross welded by a type of resistance process which resembles both butt welding and cross wire welding. The bars are placed crosswise, welded and simultaneously pressed together in a machine resembling the conventional hydraulic press. The process is termed electroforging.

Stored Energy Systems

Since high current values are required to give short-cycle welds, and since the load is at a very low power factor, a high peak demand is made upon the power supply. Stored energy systems have been devised to help reduce these peaks. Energy is drawn from the supply line between welds, stored in a transformer (electromagnetic or inductor type) or in a bank of capacitors (electrostatic or capacitor type) and drawn off to supply the peak current when the welding circuit is closed. Three-phase current is rectified to direct current for these storage types, so that the procedure is sometimes called D.C. welding.

For the inductor storage system, the rectified line current is drawn into the transformer primary, and stored as energy in the iron core, during the interval between welds. When the weld is to be made the line current is cut off, the magnetic flux collapses, and a high current is induced in the secondary. This is the welding current.

The capacitor system utilizes the charging of a condenser as its means of energy storage. Again, the energy is charged into the bank of capacitors over a comparatively long time between welds, and drawn off by discharging the capacitors to make the weld.

Aluminum, which requires high currents for successful welding, is frequently welded by the energy storage type of equipment. It must be pointed out that the standard welding machines are used, but that control, timing, current supply and similar auxiliary equipment is entirely different.

What can be done with the stored-energy type of equipment is shown in the experience of an Illinois plant. Here a seam welder, costing about $8500 installed, was pulling about 150 kva from a single phase 440 volt circuit, resulting in a serious wiring and power factor problem. Series capacitors, costing about $1200 installed, were added to flatten out the demand, which was reduced to 54.6 kva.

Most of these welding processes require only semi-skilled labor, and unskilled workers may usually be used on the spot or projection welders. When provided with the proper fixtures or dies, the operation of these machines is as routine as that of a stamping machine or punch press. The flash process will generally require a higher degree of skill in the operator than other resistance welding methods.

Some Typical Jobs: Spot Welding

Typical of the installations in which portable spot welders are grouped for successive operations is one at a Buffalo, N. Y., plant. A number of metal stampings were to be welded together to form an aircraft part. Eight spot welders were arranged inside a circular track about 20 ft. in diameter, over which a conveyor moved in an endless circle. At the first station the metal stampings are put into fixtures, and the conveyor table moves on under each gun in turn, each with a specific operation to perform. At the final station the finished piece is removed from the fixture, and the conveyor moves on to the first station again. About 10 fixtures, permanently mounted on the conveyor table, keep the entire group in continuous operation.

The controls for the welders are located at the center of this conveyor, and welding transformers and tanks of cooling water for the electrodes are overhead. The power, air and cooling lines for the guns hang down to the assembly line.

Savings by Spot Welding

The army has standardized upon a type of 5-gal. gasoline can, of which the body is drawn from sheet steel. The metal, drawn hard and thin by the forming operations, made welding-on of the handles difficult because of the ease with which the arc burned through. Spot welding was adopted, and the single weld required saved 80 per cent of the time formerly required.

Spot welding of steel switchgear has been found to be five times faster than arc welding, almost as much faster than bolting, and almost six and one-half times faster than riveting. Welding the studs onto the gear panels of switchgear eliminates seven operations formerly required — punching a hole in the panel, threading the hole, counter-sinking for the screw head, inserting the screw, locking the screw by peening, grinding the peened surfaces smooth, and filling in the rough surface with filler.

Heavy anchor chain, which must pass severe proof testing, is being made by the flash-butt process. Flash welding of low carbon shanks to high carbon cutting tools has become an important tool salvage and metal conservation procedure.

An interesting use which has invaded many fields is the combination of metal stampings to form sheet metal pieces which have the form of castings. Weldments frequently have a tendency to squareness, losing the pleasing streamlined, rounded surfaces and edges of castings in order to cut down the number of inches of welding. It has been found possible, however, to combine stampings and pressings of metal in such a way as to reproduce the outlines typical of castings, and still to show definite economies. A metal saving is most obvious, since thinner sections of sheet metal can be used than could be cast easily.

The welded sheet metal is also stronger than the very thin cast sections, and if warped may be sprung into shape. Size limits are almost nonexistent, since many small sections can be built up to make the final piece. Machining, especially drilling, may be done upon the flat piece before welding into place, saving the cost of a fixture if the hole would be awkwardly placed. Saving of the cost of patterns, their storage and repair, is also a substantial item.

A new process, termed cyclo-welding, has been introduced for sheet metal fabrication. Not welding in the sense of fusing together of metals, it has been used for metal joining in a manner similar to the making of plywood or of shatterproof glass. A thermoplastic resin is placed between the metal surfaces and fused by induction heating to bond the metal. While in no sense is this a type of resistance welding, it is mentioned here because the joint strengths obtained are so great as to establish cyclo-welding as a probable strong competitor for spot and seam welding in the years ahead.

METALS and ALLOYS

Engineering File Facts

NUMBER 22

PROCESSES AND PROCEDURES
Welding, Resistance

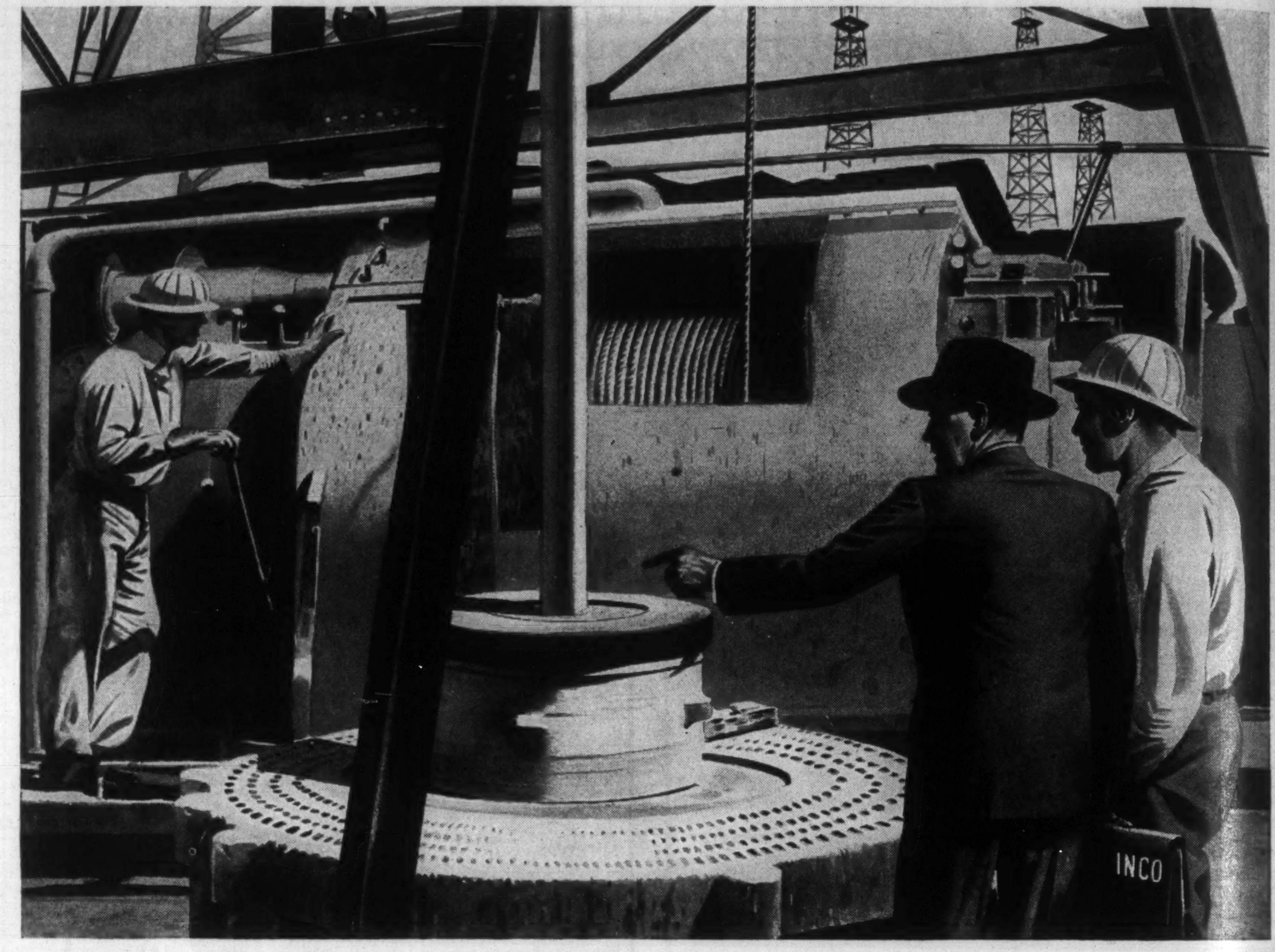
Properties Affecting Resistance Welding

Two of the most important properties of metals in determining their weldability by resistance methods are thermal and electrical conductivity. Thermal conductivity influences the rate at which the welding heat is dissipated through the metal from the weld area, while electrical conductivity, the reciprocal of resistance, determines the amount of heat generated by the welding current.

Metal	Thermal Conductivity G. cal./sec./sq. cm./°C./cm.	Electrical Conductivity, as Equivalent % of Copper
Aluminum	0.4801	64.1
Antimony	0.0442	4.4
Beryllium	——	17.1
Brass, yellow 65-35, hard-drawn	0.285	26.0
Cadmium	0.222	22.9
Chromium	——	66.4
Cobalt	——	17.8
Copper	0.918	100.0
Cupro Nickel 20% hard-drawn	0.087	6.5
Duralumin 17ST	0.34	36.0
Gold	0.705	70.9
Iridium	0.141	28.3
Iron (99-97%)	0.18	17.6
Lead	0.083	7.8
Magnesium	0.376	38.7
Manganese	——	34.5
Mercury	0.0148	1.8
Molybdenum	0.346	34.0
Monel metal, cold drawn	0.06	4.0

Metal	Thermal Conductivity G. cal./sec./sq. cm./°C./cm.	Electrical Conductivity, as Equivalent % of Copper
Nickel	0.03	1.5
Nickel-Chrome, annealed, 80% Ni, 20% Cr	0.14	22.2
Nickel Silver 25%, hard-drawn	0.06	4.0
Osmium	——	18.2
Palladium	0.168	15.7
Phosphor Bronze 50% Sn, hard-drawn	0.195	18.0
Platinum	0.1664	17.6
Rhodium	——	33.8
Silicon Bronze (Everdur) hard-drawn	0.078	6.5
Silver	1.006	105.8
Steel, structural	0.14	15.0
Steel, stainless annealed	0.04	2.0
Tantalum	0.130	11.1
Tellurium	0.0143	0.09
Tin	0.155	15.0
Titanium	——	57.5
Tungsten	0.476	31.4
Zinc	0.265	33.0

Compiled by Kenneth Rose, Engineering Editor



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to KEEP 'EM PRODUCING!

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Besides power for ships and subs, planes and tanks, trucks and jeeps, it also provides the basic ingredients for synthetic rubber, toluene for TNT, chemicals, and many other essential war materials.

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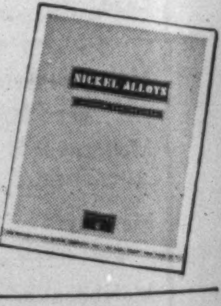

* ***Nickel*** *

THE INTERNATIONAL NICKEL COMPANY, INC., *67 Wall St., New York 5, N. Y.*

Leaded Bronzes

A Digest of Common Specifications

This summary includes many of the common specifications and analyses of leaded bronzes (copper tin alloys containing lead and a relatively low percentage of zinc.) Data obtained from ASTM Standards (1942 Ed.), SAE Handbook (1942 Ed.), and Specifications Branch, Conservation Div., W.P.B.

Name	Characteristics	Specifications	Form or Grade	Composition, per cent				
				Cu	Sn	Pb	Zn	Others (max. except P)
Phosphor Bronze	This specification covers sheet and strip suitable for drawing, forming, stamping and bending, and is often used for making flat springs for electrical equipment.	ASTM B103, Grade B	Phosphor bronze sheet and strip	Rem.	4.00-5.50	2.50-4.00	0.20 max.	P 0.03-0.25
Commercial "G" (87-10-1-2)	A general purpose material for sand castings (valves, centrifugal pump casings, etc. subject to moderate steam or hydraulic pressures — not over 500 p.s.i. or 500° F.); also used for backings for some lined bearings and for structural parts.	ASTM B143, Alloy 2B	Leaded tin bronze sand castings	86.00-89.00	9.00-11.00	0.75-1.50	1.00-3.00	Ni 1.00
		ASTM B30, Alloy 2B	Copper-base alloys in ingot form for sand castings	86.50-88.50	9.25-10.50	0.75-1.25	1.25-2.50	Ni 1.00
Commercial "G" (87-8-1-4)	A substitute for the above alloy suitable for large bearings and structural parts; can be made of high purity secondary metals.	ASTM EA-B30, Alloy 2X	Emergency alternate for above alloy	86.00-89.00	7.50-9.00	0.90 max.	3.00-5.00	Ni 1.00
		ASTM EA-B143, Alloy 2X	Emergency alternate for tin bronze sand castings B143	86.00-89.00	7.50-9.00	1.00 max.	3.00-5.00	Ni 1.00
	An emergency alternate for ASTM B143, Alloy 1B when used for bearings and structural parts.	ASTM EA-B143, Alloy 2Z	Emergency alternate for tin bronze sand castings B143	85.00-88.00	7.50-9.00	1.00-2.50	3.00-5.00	Ni 1.00
Steam or Valve Bronze or Composition "M" (88-6-2-4)	Sand cast valves and fittings subject to moderate pressures and temperatures are made of this alloy; may be used as a substitute for ASTM B143, Alloys 1A and 1B when used for pressure resistant parts; can be made from selected secondary to which tin has been added.	ASTM B143, Alloy 2A*	Leaded tin bronze sand castings	86.50 min.	5.50-6.50	1.00-2.00	2.50-5.00	Ni 1.00
		ASTM B30, Alloy 2A	Copper-base alloys in ingot form for sand castings.	87.00-89.00	5.75-6.50	1.25-1.75	3.50-5.00	Ni 1.00
		ASTM EA-B30, Alloy 2Z	Emergency alternate for copper-base alloys in ingot form for sand castings	85.00-88.00	7.50-9.00	1.00-2.25	3.00-5.00	Ni 1.00
Leaded Gun Metal	Another general utility bronze for castings; it is used especially for bushings subject to severe operating conditions.	SAE 63	Leaded gun metal castings	86.00-89.00	9.00-11.00	1.00-2.50	0.50 max.	P 0.25
Bearing Bronze	Makes a good bearing surface and is used for bronze backed bearings. Its anti-friction qualities make it useful for bushings.	SAE 66	Bronze backing for lined bearings	83.00-86.00	4.50-6.00	8.00-10.00	2.00 max.	0.25
		SAE 660	Bronze bearing castings	81.00-85.00	6.50-7.50	6.00-8.00	2.00-4.00	Fe 0.20
High Leaded Tin Bronze (85-5-9-1)	This alloy has good anti-friction qualities as well as desirable machining and casting properties.	ASTM B30, Alloy 3C	Copper-base alloys in ingot form for sand castings	83.00-85.00	4.50-5.50	8.50-10.00	0.50-1.50	Ni 0.50
		ASTM B144, Alloy 3C**	High leaded tin bronze sand castings	83.00-86.00	4.50-6.00	8.00-10.00	0.50-2.00	Ni 0.50

**Note: ASTM B143 Alloy 2A supersedes ASTM B61.*
***ASTM B144 specification to replace ASTM B74.*

(Continued on page 533)

Announcing

IRIDITE

The New, Super-thin, easy-to-apply coating that protects zinc and cadmium surfaces against corrosion

Here is a new chemical coating that is unusually simple in application and low in cost. When *Iridite* is applied it is "soaked up" by the plated metal . . . becomes integral with it. That's why *Iridite* cannot chip or flake off.

Caused by a chemical reaction with the metal itself, *Iridite* is uniform, opaque and olive drab in color . . . matching the familiar shade used by the armed forces for camouflage.

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The *Iridite* process greatly increases the field of usefulness of zinc and cadmium as protective coatings.

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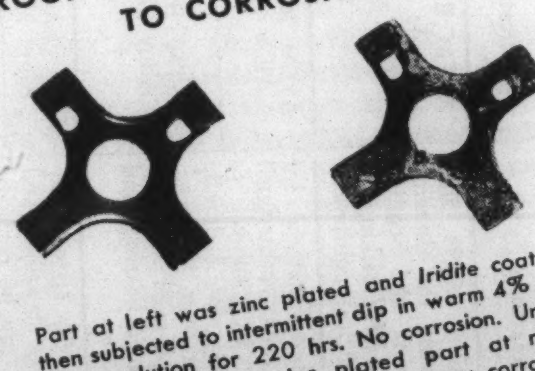
Plated parts are protected by the *Iridite* process by simply dipping them in the *Iridite* solution from 10 to 60 seconds, and rinsing in hot water immediately afterwards. Hot water is preferred in order to facilitate drying. The drying of the water from the part may be done by compressed air or by whatever other means are available. As soon as the part is dry it can be handled and shipped.

The only equipment needed are an acid-proof container for *Iridite* solution and a container for the hot water rinse. The *Iridite* solution is used at a temperature of from 75° to 100° F. depending on individual requirements.

The *Iridite* process can be applied to plated parts of any type or size, except in containers for edible products.

If you manufacture parts that are exposed to weather or to corrosion (except containers for food), you should send, immediately, for full details on the *Iridite* process. Better still, send us a part for *Iridite* coating, and test it any way you like. And, if your proposed use of *Iridite* requires an inspection of your production lines, our technical representative is at your service.

PROOF OF IRIDITE'S RESISTANCE TO CORROSION



Part at left was zinc plated and *Iridite* coated, then subjected to intermittent dip in warm 4% salt water solution for 220 hrs. No corrosion. Under identical conditions zinc plated part at right, without *Iridite* protection, shows heavy corrosion.

RHEEM RESEARCH PRODUCTS, INC.

Subsidiary of RHEEM MANUFACTURING CO., 1209 E. 25th St., Baltimore, Md.

METALS and ALLOYS

Engineering File Facts

NUMBER 23 (Continued)

LEADED BRONZES

Name	Characteristics	Specifications	Form or Grade	Composition, per cent				
				Cu	Sn	Pb	Zn	Others (max. except P)
Bearing Bronze (83-7-7-3)	Similar in characteristics to 85-5-9-1 alloy and can be made from secondary and scrap metals.	ASTM B30, Alloy 3B	Copper-base alloys in ingot form for sand castings	82.00-84.00	6.50-7.50	6.50-8.00	2.50-4.00	Ni 0.50
		ASTM B144, Alloy 3B	High leaded tin bronze sand castings	81.00-85.00	6.25-7.50	6.00-8.00	2.00-4.00	Ni 0.50
Bearing Bronze (84-8-8)	A zinc-free bearing alloy that may be substituted for higher tin alloys; can be made from tin-enriched selected secondary metals.	ASTM EA-B144, Alloy 3Y	Emergency alternate for leaded tin bronze sand castings	82.00-85.00	7.00-9.00	7.00-9.00	0.75 max.	Ni 1.00
		ASTM EA-B30, Alloy 3Y	Emergency alternate spec. for copper-base alloys in ingot form for sand castings	82.00-85.00	7.00-9.00	7.00-9.00	0.75 max.	Ni 1.00
Bearing Bronze (80-10-10)	This alloy has excellent anti-friction and wear resistant qualities and parts made of it can withstand very severe usage; can be made from selected secondary; may be cast in sand or metal molds.	SAE 64	Phosphor bronze castings	78.50-81.50	9.00-11.00	9.00-11.00	0.75 max.	P 0.05-0.25
		ASTM B66, Phosphor Bronze	Bronze castings in the rough for locomotive wearing parts	Rem.	9.00-11.00	9.00-11.00	0.5 max.	P 0.2-0.4
		ASTM B144, Alloy 3A	High leaded tin bronze sand castings	77.00-81.00	9.00-11.00	8.00-11.00	0.75 max.	Ni 0.50
		ASTM B22, Class C	Bronze castings for turntables and movable bridges and for bearings and expansion plates of fixed bridges	Rem.	9.00-11.00	9.00-11.00	0.50 max.	Ni 6.00
		ASTM B30, Alloy 3A	Copper-base alloys in ingot form for sand castings	78.00-81.00	9.25-10.50	9.00-11.00	0.75 max.	Sb 0.50
Bearing Bronze (80-7-10-3)	A lower tin bearing alloy that may be substituted for the 80-10-10 composition; this, also, can be made from secondary and scrap metals.	ASTM EA-B144, Alloy 3Y	Emergency alternate spec. for high leaded tin bronze sand castings	77.00-81.00	6.00-7.50	8.00-11.00	2.00-4.00	Sb 0.75
		ASTM EA-B30, Alloy 3X	Emergency alternate spec. for copper-base alloys in ingot form for sand castings	77.00-81.00	6.00-7.50	8.00-11.00	2.00-4.00	Ni 0.50
		ASTM B66, Hard Bronze	Bronze castings in the rough for locomotive wearing parts	Rem.	7.00-10.00	10.00-15.00	1.25 max.	0.75

(Continued on page 534)

METALS and ALLOYS

Engineering File Facts

NUMBER 23 (Continued)

LEADED BRONZES

Name	Characteristics	Specifications	Form or Grade	Composition, per cent				
				Cu	Sn	Pb	Zn	Others (max. except P)
Semi-Plastic Bronze	This is a medium soft bronze for liners and bearings — may be cast in sand or metal molds.	ASTM B30, Alloy 3D	Copper-base alloys in ingot form for sand castings	76.00-79.00	6.50-7.50	14.00-16.00	0.75 max.	Sb 0.75
		SAE 67	Semi - plastic bronze castings	76.50-79.50	5.00-7.00	14.50-17.50	4.00 max.	Sb 0.40
		ASTM EA-B30, Alloy 3Z	Emergency alternate spec. for copper-base alloys in ingot form for sand castings	75.00-79.00	5.50-7.00	13.00-16.00	1.25 max.	Ni 0.75
		ASTM B144, Alloy 3D	High leaded tin bronze sand castings	75.00-79.00	6.25-7.50	13.00-16.00	0.75 max.	Ni 0.75
	A substitute for ASTM B144, Alloy 3D that can be made from secondary metals.	ASTM EA-B144, Alloy 3Z	Emergency alternate spec. for leaded tin bronze sand castings	75.00-79.00	5.50-7.00	13.00-16.00	1.25 max.	Ni 0.75
Medium Bronze	Parts requiring a long wearing surface may be cast of this material in sand or metal molds.	ASTM B66, Medium Bronze	Bronze castings in the rough for locomotive wearing parts	Rem.	6-8	14.00-22.00	1.25 max.	0.75
Soft Bronze (70-5-25)	This is a soft alloy for bearings and bushings for special purpose applications; usually cast in metal molds; secondary metals may be used in its manufacture.	ASTM B66, Soft Bronze	Bronze castings in the rough for locomotive wearing parts	Rem.	0-6	23.00-27.00	0.75 max.	0.75
		ASTM B30, Alloy 3E	Copper-base alloys in ingot form for sand castings	68.00-71.00	4.50-5.50	23.50-26.50	0.50 max.	Ni 0.50
		ASTM EA-B30, Alloy 3W	Emergency alternate spec. for copper-base alloys in ingot form for sand castings	67.00-71.00	4.00-5.50	23.00-27.00	0.75 max.	Ni 1.00
		ASTM B144, Alloy 3E	High leaded tin bronze sand castings	67.00-71.00	4.25-5.50	23.00-27.00	0.50 max.	Ni 1.00
		ASTM EA-B144, Alloy 3W	Emergency alternate for B-144	67.00-71.00	4.00-5.50	23.00-27.00	0.75 max.	Ni 0.75

Compiled by Robert S. Burpo, Jr.

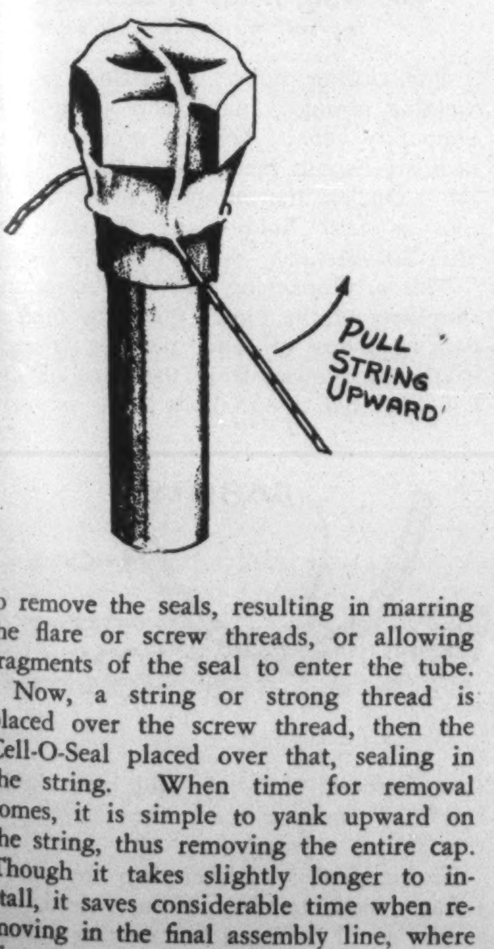
METALLURGICAL ENGINEERING shop notes

Strings Under "Cell-O-Seals"

by Granville Baum,
Airplane Div.,
Curtiss-Wright Corp.

Often the simplest idea is the best. Formerly, to protect the end threads and seal the interior of hydraulic tubing, a wet "Cell-O-Seal" (a plastic compound) was placed over the end, and when it dried it shrank to an air-tight seal. This was effective enough until it came time to remove the seal.

Often knives, screw drivers, other metal tools or even fingernails were used to remove the seals, resulting in marring the flare or screw threads, or allowing fragments of the seal to enter the tube.



Now, a string or strong thread is placed over the screw thread, then the Cell-O-Seal placed over that, sealing in the string. When time for removal comes, it is simple to yank upward on the string, thus removing the entire cap. Though it takes slightly longer to install, it saves considerable time when removing in the final assembly line, where time is most important.

[The author received recognition from the War Production Board for this idea. —The Editors]

Hardening Shifter Rods

by James Graham, Sr.,
Willamette Hyster Co.

In hardening shifter rods, it was formerly necessary to pack the parts in carburizing material in iron pots, place them in the electric furnace, bring it up to about 1700 deg. F., hold it there for 6 hours, remove the pot from the furnace and let cool down, put the parts back in the furnace loose and bring up to 1500 deg. F., then quench in water one at a time and sand blast.

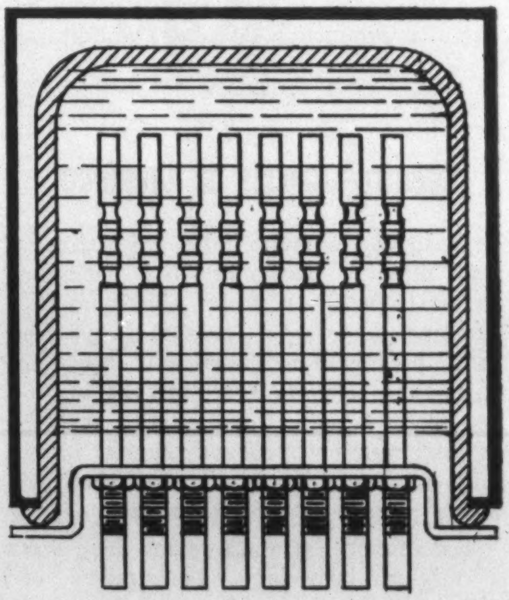
An average of 12 shifter rods could be treated at a time and the process required about 16 hours (with the result that at least one furnace was tied up). Invariably this bent some of the rods, many of which would break upon being straightened, the loss being considerable.

Our new method was liquid carburizing, using a special fixture to hold the pieces in a vertical position, immersing only to the depth necessary to harden the portion subject to wear, leaving the threaded portion (which extends outside the transmission) of normal hardness.

We use a great many shifter rods in the transmissions of our various models of towing winches and tractor donkeys for tractors as well as in our lift trucks, straddle trucks, and mobile cranes. These shifter rods have grooves turned in them in which a retaining ball engages to hold the shifter gear or clutch in the position selected. They are made in various diameters and lengths, depending on the size of the machine.

With the new method, nuts are started on the threads to serve as stops, and the rods are placed in the holes of the special fixture, which is located so as to permit the rods to be immersed to the required depth only. After cooking in the liquid carburizing material in this vertical position for 90 minutes, they are lifted out and dropped into the holes of a similar fixture over the water bath so as to quench only the portion needing case hardness. No sand blasting is needed, and rarely is a rod bent in the slightest, so no straightening is necessary.

A batch of 100 shifter rods can be hardened by the present method, doing them ten at a time in 15 hours, but the time required by the old method would be about 128 hours, putting them through in lots of twelve rods to each furnace load, taking 16 hours each.



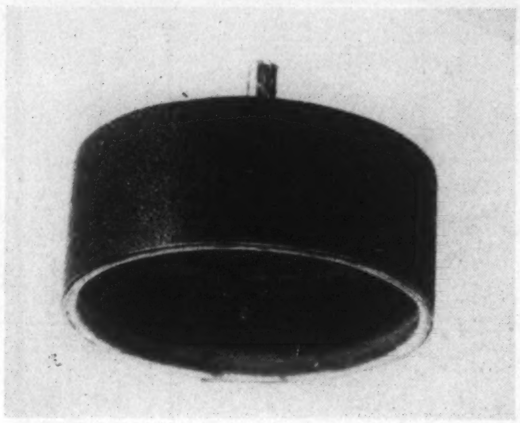
The accompanying sketch is a cross section through the carburizing pot.

[The author won honorable mention from the War Production Board.—The Editors]

Polishing Tungsten Carbide

by Rudolph W. Nothnick,
Pratt & Whitney Div.,
Niles-Bement-Pond Co.

An inside polishing wheel employing diamond dust to polish tungsten carbide devised by us at our plant accomplished two main results: It did in a few minutes what it took hours for previous hand polishing to do; and it conserved expensive diamond dust.



The wheel is made from sheet metal and felt, shaped as a cylinder closed at one end, the inside being lined with felt. Attached is a shaft, to be inserted in the collet of a speed lathe or the chuck of the bench motor.

To operate, one starts the bench motor, impregnating the felt with a few drops of oil and diamond dust. Then, one presses the tungsten carbide piece to be polished against the felt. Centrifugal force tends to throw dislodged diamond dust back into the felt. Thus, the dust may be used at high speed without loss.

[The author's idea was honored by the War Production Board.—The Editors]

Spectro-analysis of Aluminum

Analyzing aluminum by spectrographs and films is becoming "big business" in the laboratories of the Aluminum Co. of America. About 450,000 ft. of 35-mm. photographic films will be used this year. The 43 spectrographs in Alcoa plants provide "on-the-spot" analysis of vital war materials and promote quick and accurate identification of the elements present in a metal sample.

For instance, at a war plant there was a mix-up involving 5,000 pieces of aluminum aircraft tubing made of a variety of different alloys. With the spectrograph, each piece was identified definitely, with no damage to the tubing, and scrapping was averted.

One surface of the item to be tested is machined flat and placed on a little stand on the spectrograph, smooth side down, immediately below which is a carbon rod. A high-voltage current is introduced into the rod and the sample, a spark jumping between them. The light of the spark is projected into the "spectro" and broken up, or diffracted, into the various wave lengths present, the results being recorded on the film.

This film is then placed in a "densitometer," which projects an image of the spectrum picture on a screen. An electric eye looks over the various lines on the screen and indicates kind and intensity of light that produced them. By means of a calculator the operator can translate the photoelectric cell readings into percentage figures. In short, the operator learns what elements are present, and in what percentages.

Aluminum Co. of America

Because of the redesign of an automobile motor assembly, which necessitated the drilling of a small hole, the assembly had to be taken apart, thereby losing time and damaging the engine at this Pontiac, Michigan plant. But we took a piece of discarded fuel line tubing, bent it at several angles so that it could be inserted through a maze of gadgets, and placed inside the tubing a speedometer cable. We welded a drill to one end and attached an electric motor to the other. The drill was magnetized so as to remove all drillings, chips and filings.

—Ernest W. Nord,
Yellow Truck & Coach Co.

Induction Hardening of 35 Parts

by T. E. Eagan,
Cooper-Bessemer Corp.

Another good illustration of effectiveness of hardening by electrical induction is that at the plants of the Cooper-Bessemer Corp. Some 35 parts of diesels, gas engines and compressors were formerly hardened by carburizing. These parts range from 7/16-in. bolts to large diesel wrist pins, over 6 in. in diam. and up to 18¼ in. long. These are now hardened accurately to the desired degree and depth in less than half the time formerly required.

We often demonstrate the simplicity of the process by placing a crankshaft for a diesel pump into place on the machine. By pressing a button, the selected bearing surfaces of the crankshaft become red-hot within a few seconds; then jets of water automatically spray the heated areas, thus quenching and completing the hardening operation.

By merely changing the fixture and induction coils, many of which are designed and built in the Cooper-Bessemer plant, the machine is prepared to accommodate any one of the 35 items, which include such parts as gears, cams, wrist pins and ball races.

In hardening wrist pins, an automatic hydraulically-operated fixture feeds the pin through the coils at a controlled speed, the entire length being heated to the desired temperature and quenched in one continuous operation. Hardening time is now only 38 sec. Distortion is reduced to a minimum, and carbon steel replaces high alloy.

Rapid Annealing of Malleable Iron

Whiting Corporation
by C. R. Taylor,

In these days of hurry-hurry war production, an important contribution in malleable iron foundries is more efficient annealing ovens. Small 6- to 16-ton capacity car-type ovens are being reserved for rush jobs in some foundries where annealed castings can be turned out in 3½ to 4 days instead of the usual 6 to 7 days needed in the large ovens.

Ovens are being designed to conserve heat and speed up the process. Typical new ovens have been built with 9-in. insulating fire brick walls backed by 2½ in. of secondary insulation, a combination that has reduced the heating period by as much as 50 per cent. Also, the "smaller heat capacity" of the insulating fire brick considerably accelerates the cooling period.

These small ovens can be unloaded and reloaded quickly. Vertical lift doors are open only long enough to allow car entrance or exit, thereby conserving much residual oven's heat.

They are most economically fired with pulverized coal supplied by a small pulverizer and single burner, both at the oven's rear. The flame passes over and through the charge to the front of the oven, turns down and back and into two flues in the rear wall. By keeping a slight pressure in the oven, a uniform temperature may be maintained throughout the entire charge.

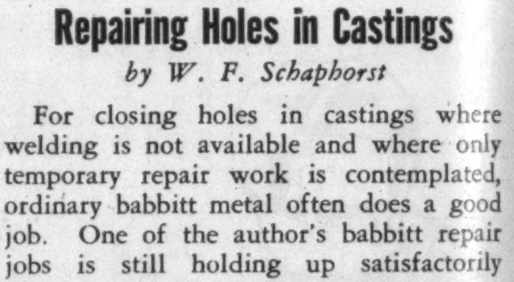
As to relative economies between pulverized coal and oil, if oil costs more than 2.4 cents per gal., it is cheaper to use the coal.

Repairing Holes in Castings

by W. F. Schaphorst

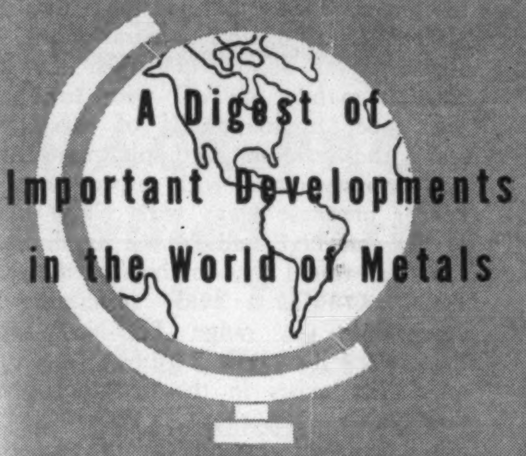
For closing holes in castings where welding is not available and where only temporary repair work is contemplated, ordinary babbitt metal often does a good job. One of the author's babbitt repair jobs is still holding up satisfactorily after 20 years.

The accompanying sketch shows the simplicity of the idea. Place the broken part in a box of sand, pushing enough of the sand away from the edge of the hole so that the babbitt will securely clamp around the hole and catch both sides. Then pour the melted babbitt, a very simple process.



The method is quicker than any other I have encountered. Ordinary lead, or similar metal having a low melting point, can be used in place of babbitt.

Metallurgical Engineering Digest



A Digest of
Important Developments
in the World of Metals

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1

Metal Production

Blast Furnace Practice, Smelting, Direct Reduction and Electrorefining • Open-Hearth, Bessemer, Electric Furnace Melting Practice, Equipment and Refractories • Melting and Manufacture of Non Ferrous Metals and Alloys • Soaking Pits and other Steel-Mill and Non-Ferrous-Mill Heating Furnaces • Steel and Non-Ferrous Rolling, Wire Mill, Pickling and Heavy Forging Practice

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Hot Rolling Clad Steel

Condensed from
"Mitt. Kaiser-Wilhelm Inst.
Eisenforsch. Düsseldorf"

Experiments were made with the tabulated materials from which the clad sheets were prepared:

Material	% C	% Si	% Mn	% P	% S	% Cr	% Ni	Hardness
Steel, not plated	0.09	trace	0.55	0.042	0.043	—	—	not detd.
Steel, with copper plating	0.06	trace	0.41	0.046	0.054	—	—	103
Steel with 18/8 stainless cladding	0.04	trace	0.40	0.042	0.045	—	—	121
Copper	—	—	—	—	—	—	—	48
18/8 Cr-Ni steel	0.07	0.62	0.42	0.006	0.017	17.4	8.50	187

The thickness of the plated layer was 5, 10 and 20 per cent of the total thickness of the bar (plated on one or both sides). Roll pressure, increase of width and forward slip were determined as functions of the reduction in thickness at temperatures from 1300 to 2200 deg. F.

The results show that, for the plain materials, the differences in rolling pressure vary much with temperature, while the increase in width was practically not influenced and the forward slip only very little by the kind of material. The effect of rolling temperature and decrease in thickness was the same as in rolling other materials.

The results from rolling the clad materials show that the rolling pressure of such materials are composed of the rolling pressures of the individual materials in the ratio of the thickness of the individual layers to the total thickness of the bar. The increase in width was always greater than that of the base material if plated with copper, but smaller when plated with 18/8; this is ascribed to the different deformation resistance of the materials combined.

It was furthermore found that the adhesion between base and plated-on material is apparently not sufficient to prevent sliding of the materials in the plane of adhesion if the deformation strengths of the combined materials differ by more than 100 per cent.

—A. Pomp & W. Leug, *Mitt. Kaiser-Wilhelm Inst. Eisenforsch. Düsseldorf,* Vol. 24, No. 9, 1942, pp. 123-137.

Steelmaking Slags

Condensed from
"Mitteilungen," Kaiser-Wilhelm
Inst. Eisenforsch., Düsseldorf

The previously discovered fact (Oelsen & Metz, Eisenforsch, Duss. Vol. 23, pp. 135-245, 1941) that fluorspar and ferrous oxide mix only very slightly in the molten state and that in the system FeO-CaO-P_2O_5 a distinct separation in two liquid layers occurs, of which the lower consists mainly of FeO with little P_2O_5, the upper predominantly of mixtures of iron and calcium orthophosphates, was further investigated with respect to the behavior of these slags with Na_2O instead of Ca and NaF and Na Cl as fluxes.

It was found that in slags of the system FeO-Na_2O-P_2O_5 a wide miscibility gap occurs in the range FeO-Na_2O-3FeO • P_2O_5, 3Na_2O P_2O_5 although complete miscibility exists in the marginal systems FeO-Na_2O, Na_2O-P_2O_5, FeO-P_2O_5; the miscibility gap extends in the concentration triangle, starting from the FeO corner, across the ternary area in a lense-shape to the concentration point of the sodium orthophosphate.

The upper slag layer consists predominantly of mixed orthophosphate of iron and sodium of the composition pFeO (3n-p) Na_2O • nP_2O_5 with a moderate excess of FeO in solution in it. The lower layer consists most predominantly of FeO with some Fe_2O_3 and little P_2O and Na_2O.

The amount of FeO in the upper phosphate layer decreases with increasing ratio (mol Na_2O) (mol P_2O_5), and in the same manner the P_2O_5 content of the lower FeO layer. If this ratio = 3 the FeO content in the phosphate layer is already very low, <10% (FeO Fe_2O_3). For ratios less than 3 in the slag the principal amount of the Na_2O not used for the formation of 3Na_2O P_2O_5 goes into the lower FeO-rich layer.

There exists a similarity of the miscibility gap in the system FeO-Na_2-P_2O_5 with that in the system Fe-Mn-S. The use of fluxes, NaF and NaCl, intensifies the separation of the P_2O_5 from the FeO layer, but the fluxes act only on the phosphates in which they dissolve, and not on the FeO which absorb them only with difficulty in the molten state. If Na_2O is added to a slag of calcium-orthophosphate and fluorspar which lies above a FeO slag, the calcium of the upper layer is to a large extent replaced by sodium, and the lime thus formed passes into the lower layer; in this manner, calcium salts can be converted in sodium salts with simultaneous separation of the reaction products in the melting.

Manganese oxide (MnO) added to both layers goes into the upper layer in appreciable amounts only as long as the amount of Na_2O, *i.e.* mol Na_2O/mol P_2O_5, is not greater than 3. Any addition of CrO_3 is primarily absorbed by

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the lower layer almost independent of the ratio mol Na_2O/mol P_2O_5.

The oxides of vanadium differ from FeO, MnO and CrO_3 as for mol Na_2O/mol $P_2O_5 \leqq 1$ the lower FeO layer contains still a little more vanadium than the upper phosphate layer, but with increasing ratio they pass more and more into the upper layer while their content in the lower layer becomes very small. This offers the possibility of separate vanadium oxides from the oxides of iron, manganese and chromium and in the melt, but not from P_2O_5.

The metallurgical application of the results up to 2900 deg. F. are discussed and it is especially important that Na_2O in place of CaO gives a much better dephosphorization with a very high content of P_2O_5 in the slag.

—W. Oelsen & H. Wiemer, *Mitt. Kaiser-Wilhelm Inst. Eisenforsch. Düsseldorf*, Vol. 24, No. 13, 1942, pp. 167-210.

Deoxidizing Steel with Beryllium

Condensed from "Foundry Trade Journal"

In a series of studies on the properties and metallurgical uses of beryllium, reported in *Metallurgia Italiana*, L. Losana devotes one paper to the deoxidation of steel using beryllium. He compared the deoxidizing actions of manganese, silicon, aluminum and beryllium, and gives the principal formulas and data for beryllium insofar as they affect the separation of the oxide and the reduction of iron oxide.

Deoxidation constants at different temperatures show that a few per cent of beryllium gives complete deoxidation, much better results being obtained than with aluminum.

—*Foundry Trade J.*, Vol. 70, May 6, 1943, p. 1.

Magnesium Production Today

Condensed from "Mining and Metallurgy"

War has brought about a realization of the importance of the production of magnesium. It is the earth's sixth most plentiful element and the fourth most plentiful metal. Its lack of importance in the past has been due to the fact that it is never found as a metal but in combinations and that its great reactivity makes production of the pure metal difficult.

Among the various sources of the metal, dolomite, serpentine, olivine, magnesium-bearing brines and of course sea water are found in unlimited quantities in the United States. Baucite, magnesite and hydromagnesite are found in limited amounts. There is one deposit of langbeinite near Carlsbad, N. Mex. Although sea water is free, its concentration of magnesium is small and other sources can compete with it, because of other factors of materials, plant location and power costs.

Magnesium metal is silvery white, mal-

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- **Rite-Melt Cleanser**— containing no aluminum—placed on bottom of ladle or into stream or on bottom of mold.
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- **Rite-Moldcote**— for steel ingot molds—can be easily sprayed and is economical to use.

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leable and ductile weighing 109 lb. per cu. ft. On a volume basis, it is two thirds the weight of aluminum, one fifth that of nickel, one fourth that of copper. It can be cast, extruded, rolled, welded and machined. With aluminum, zinc and manganese it forms light alloys of high strength. New alloys of steel will probably be brought into competition.

Besides its use as a light metal in construction, magnesium is used as a deoxidizer in the production of nickel and some of its alloys. More important is its use in making incendiary bombs and flares. A potential use is in the production of organo-magnesium halides in organic synthesis-(Grignard's reagents).

In the United States, as a result of experiments in the production of magnesium from brine wells, made by Dr. Dow in Michigan, the Dow Chemical Co. was founded in 1890. Production, at a constant decrease in price, has risen from 122 tons in 1925 to a probable 350,000 tons in 1943.

Reduction of Magnesium

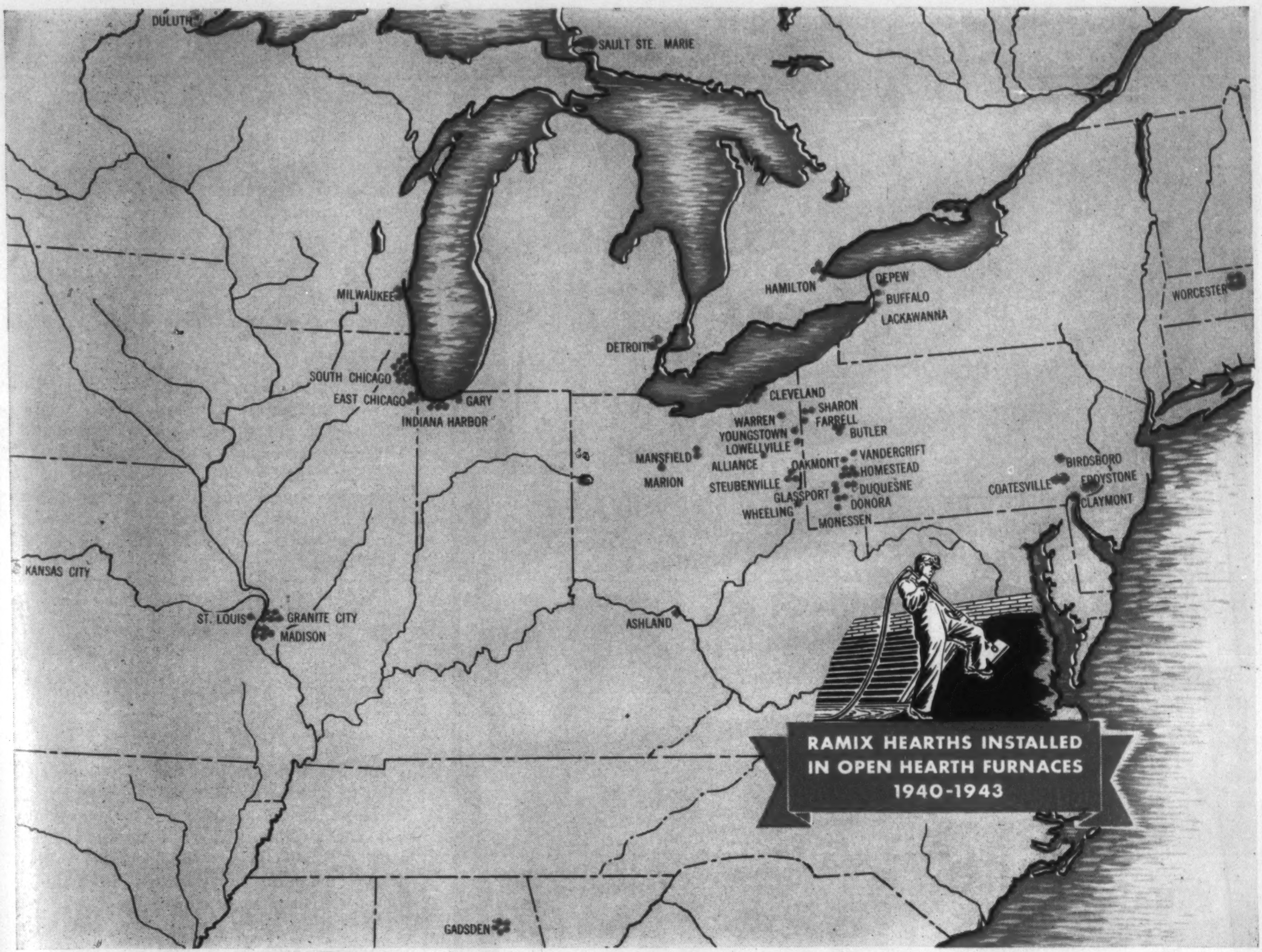
In a new plant installed by the Ford Motor Co. in Michigan, dolomite is calcined to produce "dolime." Ground to a powder, with crushed 75 per cent ferrosilicon mixed with a binder, it is briquetted and charged into chromium-nickel steel retorts, set in multiple in a furnace. A high-vacuum pump maintains the charge under as high a vacuum as possible and heat causes a reaction between the ferrosilicon and the calcined dolomite. The liberated magnesium vapor is deposited on a condenser-head, cooled by water, and the metal is deposited on sleeves at the end of the retort.

About 8 hrs. is required for the completion of the reaction, and 70 lbs. of magnesium per retort should result. Several other companies are producing magnesium by the ferrosilicon process or some modification thereof.

The Permanente Metals Co. near Los Altos, Cal. uses a modification of the Hansgirg process originally developed in Austria. Here briquets of magnesium oxide, as pure as possible, and carbon such as petroleum coke, are charged into an electric furnace to produce carbon monoxide and magnesium metal. To prevent reverse reaction, the vapor is shock-cooled by natural gas and after the removal of the magnesium dust, the mixture of gas and carbon monoxide is used as a fuel. [This company also has a plant employing the ferrosilicon process.]

The Dow Chemical Co. recently opened a plant in Texas for production of magnesium from sea water. Magnesium hydrate is produced by treating the water with lime, made by calcining oyster shells and hydrated. After further dewatering by filtration the hydrate is reacted with hydrochloric acid and the resulting magnesium chloride is used as a feed to the magnesium-producing cells. Electrolysis results in the formation of magnesium metal and a mixture of air, chlorine and hydrochloric acid.

Basic Magnesium, Inc. in Nevada, uses a process in which calcined magnesite is reacted with carbon monoxide and chlor-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RAMIX HEARTHS INSTALLED IN OPEN HEARTH FURNACES 1940-1943

"Ramix-land" at War

In more than a hundred open hearths, steel is being made on Ramix bottoms. They represent better than 12% of the basic open hearth steel capacity of America.

Since the first rammed sub-hearth was installed in a southern 150-ton furnace in March, 1940, an average of three Ramix hearths have been put in every month. They range in size from small 20-ton jobs in steel foundries to the largest. More than a dozen are in 200-ton furnaces of ultra-modern design. They are located in every important steel producing center.

Not only does every Ramix hearth installed save several days of construction—making possible 10 to 15 additional heats of steel in the time saved, Ramix also makes a clean, slag-resistant bottom that requires a minimum of maintenance and repair. Delay time is reduced, furnace output per manhour is increased, steel poured is cleaner, and quality better.

Experienced Basic Engineers are at your service to supervise the installation of Ramix bottoms. Let us know when you have a hearth job to be done.

BASIC FURNACE
REFRACTORIES

BASIC REFRACTORIES, INCORPORATED

CLEVELAND, OHIO

HAVEG

Corrosion Resistant Equipment

NON-metallic. Corrosion Resistant throughout its entire mass. Unaffected by rapid temperature changes. Can be used continuously at temperatures as high as 265° F. Seamless one piece units as large as 10 feet in diameter by 12 feet in depth. Tanks, Towers, Pipe and Fittings, Valves, Pumps, Fume Duct—available in standard sizes.

HAVEG 41

The basic standard grade of HAVEG. It is highly resistant to most acids, salts, the weaker bases, and many solvents. It is tough and strong, resists blows and shocks exceptionally well, and is unaffected by thermal shock or sustained temperatures up to 265° F. (130° C.)

HAVEG 43

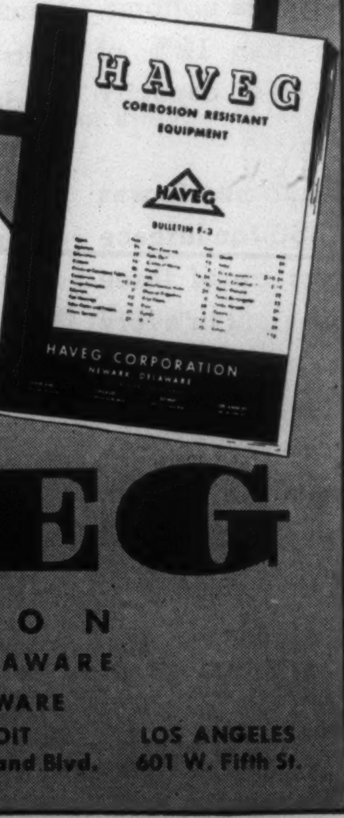
A grade developed for use with hydrofluoric acid and related compounds. While it is less resistant to shock than HAVEG 41 it is well able to withstand ordinary conditions of abuse.

HAVEG 50

An alkali resistant grade. Has effective resistance to even hot concentrated alkali solutions such as sodium hydroxide and potassium hydroxide. It is also resistant to most inorganic acids. HAVEG 50 will withstand considerable physical shock.

Write for Bulletin F-3

This bulletin gives complete chemical, mechanical and constructional data on all types of standard and special HAVEG equipment: Tanks, Towers, Pipe and Fittings, Valves, Pumps, Trays, and many other items are all fully illustrated with photographs or drawings.



HAVEG

CORPORATION

NEWARK DELAWARE

FACTORY—MARSHALLTON, DELAWARE

CLEVELAND 550 Leader Building
CHICAGO 1201 Palmolive Building
DETROIT 2832 E. Grand Blvd.
LOS ANGELES 601 W. Fifth St.

ine to form magnesium chloride and carbon dioxide. Briquets of powdered calcined magnesite mixed with lime and magnesium chloride and agents such as peat moss for porosity, are packed into the top of a vertical chlorination furnace. The lower part of the furnace is packed with coke. Magnesium chloride runs from the bottom of the furnace as a molten anhydrous liquid.

The International Minerals & Chemical Corp. in Texas and the Diamond Alkali Co. in Ohio use the Dow electrolytic cells, in each case with a different process of making the magnesium chloride. The first produces a part of the magnesium chloride as a by-product from the manufacture of potassium sulphate.

The Mathieson Alkali Works now building a magnesium metal plant in Louisiana and the Consolidated Mining and Smelting Co. of Canada together have developed a new type of electric cell using fused magnesium chloride as a feed. Chlorine is produced by this cell in a concentrated condition.

—Paul D. V. Manning, *Mining and Metallurgy*, Vol. 24, Aug. 1943, pp. 346-348.

Stopping Blast Furnace Tap-Holes

Condensed from "Metallurgia"

An improved method of stopping tapholes of blast furnaces reduces danger to operators, makes possible repeated plugging and copes efficiently with eroded brickwork. It also brings the machine to the desired position and adjusts it without the usual manual attention.

A locating outfit moves the unit into position. This is a jib-crane equipped with parallel motion guides in vertical and horizontal planes, wherein a slewing cylinder turns the jib, guiding the machine by horizontal parallel rod linkage.

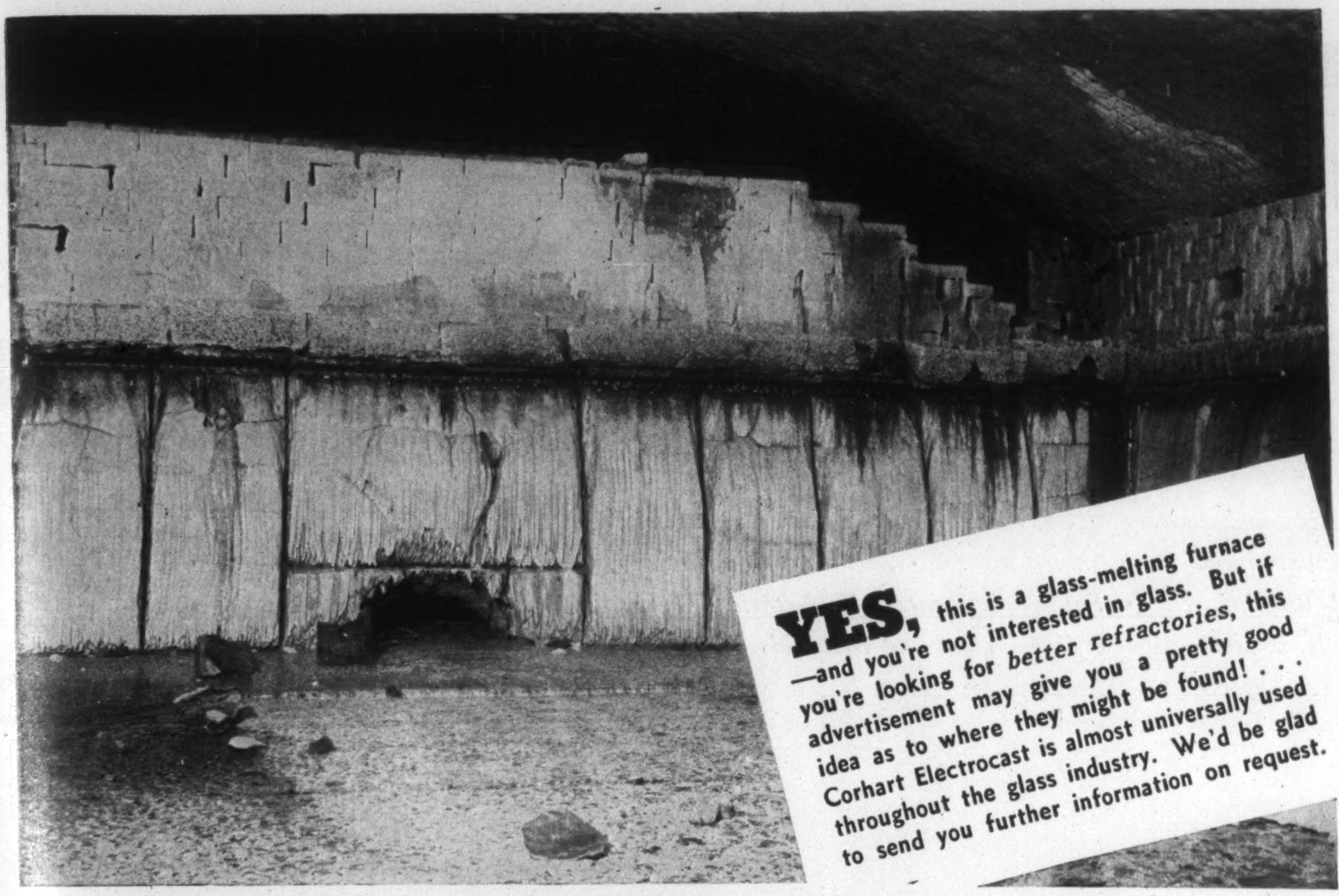
Before working position is attained a lever causes the shaft of the jib to rotate so that the barrel of the machine is inclined. "Turn-buckles" adjust this inclination to the slope of each tap-hole. Compressed air then moves the working piston forward, forcing material into the hole with uniform precision.

One operation usually closes the hole. If not, a cut-off slide closes automatically after the first operation, securing the plug against expulsion. This, together with the fact that the operating stand is set at some distance from the tap-hole minimizes accidents.

When the brickwork behind the taphole is eroded, sudden thrusting of material into the aperture must be avoided. In this process, a slow motion pushes forward the material so that it forms a mushroom in the furnace and by adapting the system of parallel linkages, which can be easily adjusted, the outfit can plug the tap-hole and also prevent undue breakage in the neighboring refractory.

One cylinder is used throughout, but as many stopping treatments can be applied as are wanted. Success is largely due to the capacious funnel which accommodates the raw material and the automatic stop-slide.

—A. G. Arend, *Metallurgia*, Vol. 27, April 1943, pp. 232-233.



YES, this is a glass-melting furnace —and you're not interested in glass. But if you're looking for *better refractories*, this advertisement may give you a pretty good idea as to where they might be found! . . . Corhart Electrocast is almost universally used throughout the glass industry. We'd be glad to send you further information on request.

This is how Corhart Electrocast looked after 984 days in the throat and bridge wall—one of the most severe spots in a glass furnace

Electrocast Blocks Still Good After 984 Days!

HERE is a performance story for a Corhart* Electrocast balanced unit—a story that is not only good but typical.

The life and production figures provoke and merit interest. Here they are—compare the last item with your own statistics.

	Fire 1940—1942
TOTAL DAYS LIFE	984 days
OPERATING DAYS	964 days
IDLE DAYS	20 days
TOTAL TONS GLASS PRODUCED	82,582
TONS GLASS PRODUCED PER OPERATING DAY	85.66
SQUARE FEET OF MELTING AREA PER TON GLASS PER OPERATING DAY	5.88
TONS OF GLASS PER SQUARE FOOT MELTING AREA PER LIFE	163.73

The glass melted throughout the campaign was a standard clear flint bottle glass.

The furnace did not fail, but was shut down at the proper seasonal point for most advantageous repairing.

Or, as our customer himself wrote us, "... when we

> were able to get into this furnace we found that the Corhart blocks were all in very good condition and we believe that we could have gotten at least six more months from this furnace which would have made the furnace run for over three years. This is what we are aiming for when we place the furnace into production again. . . ."

That's the story—a long successful life summarized in a few words.

Corhart Refractories Co., Incorporated, 16th and Lee Streets, Louisville, Kentucky.

---

*Not a product, but a registered trade-mark.

QUALITY ECONOMY
ENDURANCE

CORHART
ELECTROCAST
REFRACTORIES

2

Foundry Practice

Melting and Pouring of Gray Iron, Malleable, Steel, Brass and Bronze, Aluminum and Magnesium Castings • Molding, Core-Making, Gating nd Risering, etc. • Foundry Furnaces, Refractories, Ovens, Molds, ands, Binders, Auxiliary Equipment and Materials

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Cores for Steel Castings ——— 552

Duplexing Malleable Iron ——— 554

Gating of Castings

Condensed from
"Foundry Trade Journal"

Defects that may be caused by incorrect gating are given in the table.

Defect	Cause
Sand and slag inclusions	Lack of efficient sand and slag traps; loose sand or sharp edges in gating system; dirty or badly-made pouring basin; no choke at ingate
Misrun and cold shut	Incorrect gate distribution; slow pouring rate; poor basin design
Shrinkage	Incorrect position of gate relative to riser, *e.g.* ingate to shrink bob
Mold or core scab	Excessive mold or core surface erosion by badly placed gates
Distortion	Incorrect gate distribution

The function of the gate is obviously to introduce molten metal into the mold, but certain conditions must be fulfilled in the operation. These are principally: (1) Efficient sand and slag trapping; (2) correct heat distribution; (3) minimum mold surface erosion and (4) suitable rate of pouring.

Sand and slag trapping is probably the most important of the above conditions in relation to defective castings. For this reason, great stress is laid on this feature of gating system.

Many modifications and combinations of gates have been tried out, but the systems mainly employed for slag-trapping are: (1) Cope runner bar with drag ingates; (2) cope projection gates; (3) flow-by gate; (4) syphon skim gate; (5) whirl gate; and (6) strainer core. Correct heat distribution, mold surface erosion, pouring speed, chocking the gate and the pouring basin are also discussed.

—E. W. Harding, *Foundry Trade J.*, Vol. 69, Apr. 29, 1943, pp. 343-348.

Cores for Steel Castings

Condensed from an
Amer. Foundrymen's Assoc. Paper

The first thing to consider in a core is proper arbors or reinforcing rods to support it before and during pouring. A chaplet is always a potential source of trouble in a casting, and its elimination means more care in reinforcing the core. Cast iron arbors are easier to design and make than a steel rod support, although they should not be made too massive. At Norfolk Navy Yard the practice is against making an arbor, with prongs close to the core surface, square on the end, but to bring them to a sharp edge, which easily breaks the core during contraction. These cast arbors are never blasted or cleaned, as the rough surface holds the sand better.

In making a high pressure pipe casting, 6 in. inside diameter and 7 ft. long, without chaplets, the core was made in halves, using a cast arbor somewhat resembling a bridge truss. One half was made and rolled out on a flat plate. The second half was rammed, and the first half picked up by means of hooks cast in the arbor, and placed over the second half. The two halves were then bolted together, lifted, placed on a bed of sand and dried.

Cast iron arbors are more easily broken up than steel rods in the cleaning room, and being heavier, tend to reduce the buoyancy of the core during pouring. In cases where the hollow center of the core is accessible from outside the mold, the cast arbor can be broken at the proper time to permit the core to collapse.

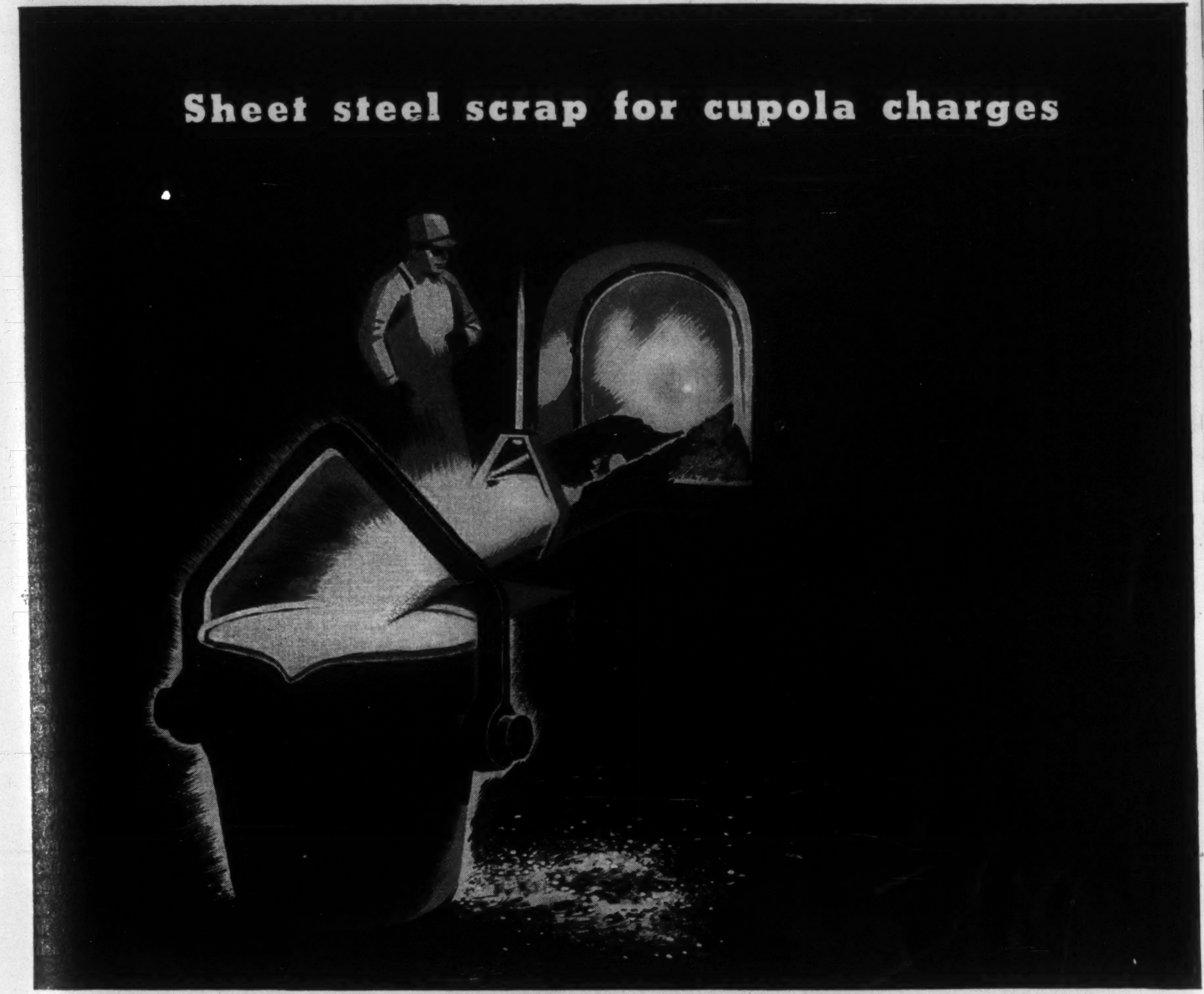
The arbor is laid out by placing a piece of wrapping paper on the core box and cutting a template with a trowel. This template is taken to a prepared arbor or "crab" bed, the outline scratched on the sand, and the mold stamped out with stamping or pricker tools. A stamping board may be used where many duplicates are required.

Core Materials

At Norfolk an oil sand, a naturally bonded sand, and a cement sand are blended in a paddle-type mixer or light muller for coremaking. Three minutes mixing, after adding oil, gives best results. Drying should not be too fast. A silica wash, sometimes a double wash, is used.

The general purpose oil sand mixture is 60 parts of No. 60 washed sand to one part linseed oil. For corrosion-resistant steels No. 100 sand is used. For heavy or thick castings the mixture used

Sheet steel scrap for cupola charges



Information supplied by an Industrial Publication

When certain precautions are observed, light steel sheet scrap (30 gauge and up) can be successfully used in cupola charges for making gray iron.

Black sheet is the best variety to use. The use of tinned, galvanized or stainless steel scrap sheet should be avoided.

When possible the scrap should be briquetted, or baled, before charging. Bundles should be smaller than those used in the open hearth, to prevent hanging in the cupola. The density of the bundles is important. Density can be controlled by varying the pressure exerted by the hydraulic press. In some cases a minimum density of 30% is specified.

When briquetting is not practicable for any reason it is possible to melt some light sheet in the charge by using a soft blast.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

MOLY

Climax Mo-lyb-den-um Company
500 Fifth Avenue • New York City

is 385 lbs. of No. 40 sand, 100 lbs. silica flour, 10 lbs. bentonite clay, 5 lbs. linseed oil and 2 quarts cereal binder, with a moisture content of 6 to 7 per cent. Experiments are being made in facing large natural bonded sand cores with this mixture. It is also used as a mold facing on large jobs, using about one-inch facing over one to two inches natural bonded sand, and the remainder backing sand.

Natural bonded sand, specified 90 to 100 A.F.A. fineness with 15 to 20 per cent clay content, has a higher green strength than the other mixtures. It is being gradually replaced by the oil sand-binder mixture.

A cement sand, 89 per cent No. 40 sand and 11 per cent high early strength cement, with 5 to 6 per cent moisture, is used for exterior work only. It helps to relieve the load on the core drying ovens, but contaminates the heap sand.

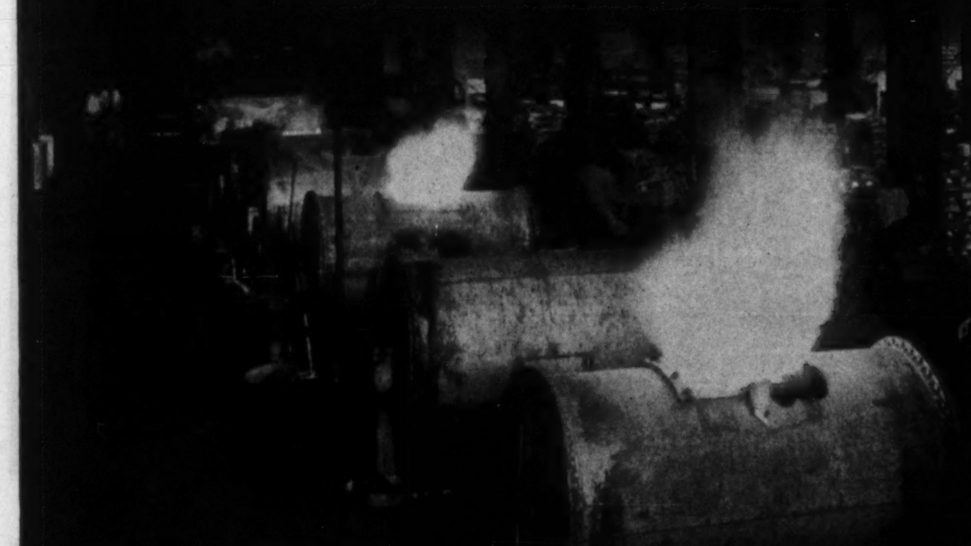
Venting in small cores is accomplished by wax tapers and by hollowing out. Large cores are made with hollow centers, or are cinder- or coke-filled.

For pressure and other cylinder work such as valves and fittings the general practice is to green top the cores, V-notching the dried drag side and using dry segments in prints to reduce the crushing load on the green top.

When chaplets cannot be used to hold down the core, it may be anchored through the bottom plate. Sections directly in front of the gate are mailed heavily. A wash made of 2 quarts bentonite, 2 quarts cereal binder, 100 pounds silica flour and 20 gallons water gives the core a smooth refractory coating. Linseed oil was discontinued in the wash as tending to cause wash penetration and cleavage between wash and core.

—S. W. Brinson and J. A. Duma,
Am. Foundrymen's Assn.,
Preprint No. 43-17, April 1943.

HAUSFELD
ALUMINUM MELTING
FURNACES



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ALL TYPES AND SIZES

SINGLE AND MULTIPLE BURNERS
GAS AND OIL FUEL
FASTER MELTING • UNIFORM ANALYSIS
LONGER LIFE FOR CRUCIBLES AND LININGS

Hausefeld Furnaces are available for melting all non-ferrous metals and their alloys. Tested before shipment.

The Campbell-Hausfeld Co.
200-220 MOORE ST. HARRISON, OHIO

Duplexing Malleable Iron

Condensed from

"Canadian Metals & Met. Industries"

Operations are described in the duplexing of malleable iron for short cycle annealing as conducted at The McKinnon Industries, Ltd., St. Catharines, Ontario. The iron is melted in the cupola, transferred to the electric furnace, superheated, and adjusted to the limits of the analysis required. It is then carried away to pouring stations where it is poured into molds which travel on a continuous conveyor system.

The electric furnace is used to superheat the iron from the cupola and for adjustment of analysis. Chemical analyses are run every ½ hr. on cupola and electric furnace products.

Metals, fuels and fluxes are carefully sampled and analyzed. A silvery coal type pig is used specially engineered for short cycle annealing with an approximate analysis of silicon 8, phosphorus 12, sulphur 0.3, manganese 1.3, chromium under 0.02 per cent. The steel scrap must be as free of high sulphur and manganese steels as possible, be fairly clean and sized to fit the cupola. Limestone and fused soda ash are examined for foreign materials.

Metallic materials are unloaded by an electromagnet crane and non-metallics by a double-jawed clam. A 3000-pound charge is used which is weighed on a traveling electric scale car.

The Cupola

The cupola is a No. 6 Whiting with a standard 66-inch shell lined to 48 inches. After 17½ hrs. continuous running, the cupola bottom is dropped and a water ring pipe cools the lining in about one hour. Clipping takes ½-¾ hrs.

The cupola is relined with cupola block and brick twice a year. A new well is put in once a month. The bosh is relined daily with firestone slabs. The cupola must be lined to the same dimension every day to insure uniform quality iron.

Special attention should be given to the installation of tap and slag blocks. A plentiful allowance must be made for expansion to avoid cracking. Channels, both outside and inside the cupola, are kept as wide as possible for easier tapping out and plugging up on the outside and reduction of the possibility of freezing up inside prior to the first tap.

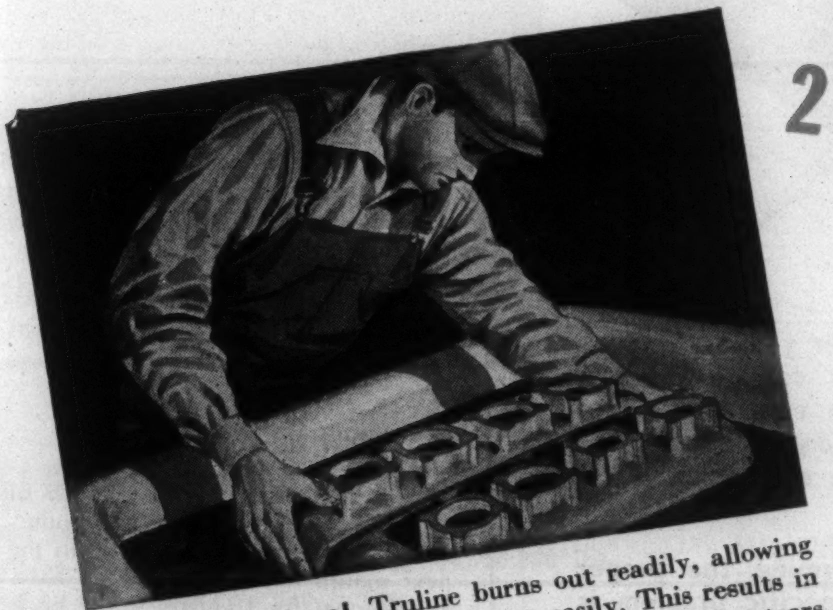
With silicon carbide slag blocks it is important to face off with 1-in. split brick

TRULINE BINDER

Three-Way Savings with TRULINE BINDER!

1 **Faster Ramming.** In the first place, Truline is easy to handle and mix. It develops an easy-flowing core sand with readily controlled green strength that has excellent core-box workability and rams easily to give smooth cores.

2 **Faster Baking.** Another advantage of Truline is that it forms a strong bond at a relatively low temperature—thus saves time in the baking oven.



3 **More OK Castings!** Truline burns out readily, allowing the core to collapse and knock out easily. This results in less clean-up time and, in addition, helps prevent hot-tears and similar defects.

How to obtain *more* production with less personnel! That's one of today's big headaches! But it's a problem Truline Binder is helping many foundries solve. Because Truline saving starts with the package —easy, convenient to handle—continues on through every step.

For further information or a sample, fill in the coupon below. No obligation.

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Please send ☐ sample ☐ information on how to use Truline Binder in casting: ....
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to prevent oxidation of silicon fluoride. The bottom sand is composed of 50 per cent malleable molding sand and 50 per cent sharp sand.

The cupola is charged to its capacity of 7 tons. The charge is preheated about 1 hr. The forehearth insures more uniform iron, keeps slag to a minimum and provides for desulphurization. It is lined with firebrick and ramped with a ladle plastic and is cleaned up and patched daily, and relined with new plastic weekly.

Correct control of the chemical and physical properties of the iron is essential and correct cupola operation is one of the most important items in the control of the cupola-electric furnace set up. Carbon absorption, gain or loss of silicon due to slag reactions and oxidation, humidity and air velocity variations in raw materials, correct weighing of charges, height of coke bed, distribution of the charge, difference in melting range of steel and pig iron, lack of circulation and proper mixing in the well are also variables that may be reduced by the presence of a forehearth and the development of a correct charging technique.

Finishing Stages

Three types of ladles are used: a 2000-lb. transfer ladle between cupola and electric furnace, a 700 lb. geared ladle, and a 400-lb. ladle. All ladles are relined once a week with a material consisting of 75 per cent ganister, 25 per cent fireclay and moisture content of 5 per cent. The spouts are rebuilt each night with a fireclay mixture containing organic binders. The ladles are heated for 2 hours to a white heat before usage.

The electric furnace is a Moore Electromelt of 1½ ton capacity but built up to handle 4 tons.

Three continuous conveyor lines, each 200 ft. long carry the molds past their respective pouring stations. At the opposite ends of the conveyor line, the molds are knocked out on a mechanical shaker. The sand is returned to the sand system, the castings are carried up a casting conveyor along which they are sorted and the sprue goes to the scrap yard.

Annealing

The five annealing furnaces are 340 kw. special atmosphere electric furnaces with air-gas ratio of 7:1 in the generator. Correct furnace atmosphere is 3 per cent carbon dioxide, 14-7 per cent carbon monoxide in the high temperature zone. At the discharge end the analysis runs: 6.7 per cent carbon dioxide and 12 per cent carbon monoxide. The oven is 71 ft. long and has room for a double row of 35 trays.

There are seven temperature zones in the furnace. No. 1 is raised to 1580 deg. F. in 4 hrs., No. 2, during 6 hrs. to 1750 deg. F., No. 3 for 6 hrs. to 1700 deg. F., No. 4 to 1675 for 1 hr., No. 5 in 2 hrs. is lowered to 1420 deg. F., No. 6 for 8 hrs. to 1360 deg. F. and No. 7 for 6 hrs. to 1320 deg. F.

Each tray position is moved along every 65 min., thus with 35 trays, the annealing time is 38 hrs.

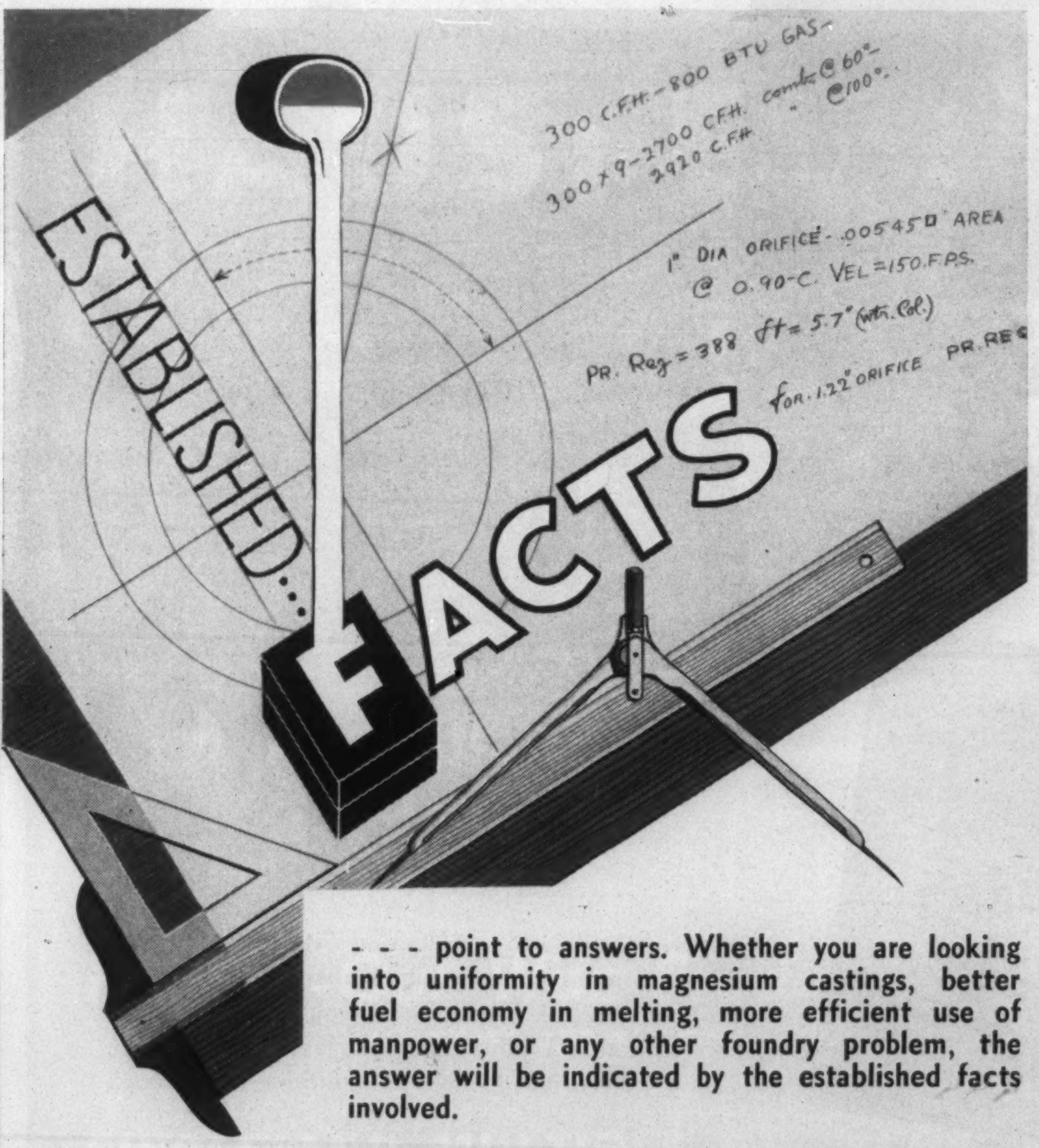
The structure of the hard iron or unannealed casting is cementite and pearlite. The annealed casting is free ferrite, temper carbon and a slight trace of pearlite under the thin decarburized skin.

—R. Williams. *Can. Metals & Met. Inds.*, Vol. 6, June 1943, pp. 34-36.

New Salvage Manual

The Industrial Salvage Branch of the Salvage Division, War Production Board will distribute within the next month its new 300-page "Salvage Manual for Industry." The book contains 25 chapters embracing all practical phases of industrial salvage activity from the organization of a plant salvage department to methods of segregating, processing, reclaiming and identifying various types of scrap. Both metals and non-metals are covered.

The book, prepared by a staff of salvage experts from industry and industrial-magazine editors, will be distributed without charge to thousands of plant salvage managers. Copies remaining after the initial distribution will be sold at a moderate price.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FACTS
300 C.F.H. - 800 BTU GAS-
300 x 9 - 2700 CFH. comb. @ 60°
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1" DIA ORIFICE - .00545□' AREA
@ 0.90-C. VEL=150.F.P.S.
PR. Reg = 388 ft = 5.7" (wtr. Col.)
for 1.22" ORIFICE PR. REG

- - - point to answers. Whether you are looking into uniformity in magnesium castings, better fuel economy in melting, more efficient use of manpower, or any other foundry problem, the answer will be indicated by the established facts involved.

Knowing the facts which determine the proper equipment and layout for the specific problem is the business of Fisher engineers. Fisher is ready with facilities to help you solve your problems, looking toward production efficiency, savings in man hours and fuel, and other advantages. We shall be glad to confer with you on equipment selection and utilization.

ESTABLISHED FACT NUMBER ONE is that proper furnaces and blowers are a basic step toward foundry improvement.

Find out the facts on Fisher equipment. Write for complete information.

5541 N. Wolcott Ave., Chicago, Illinois

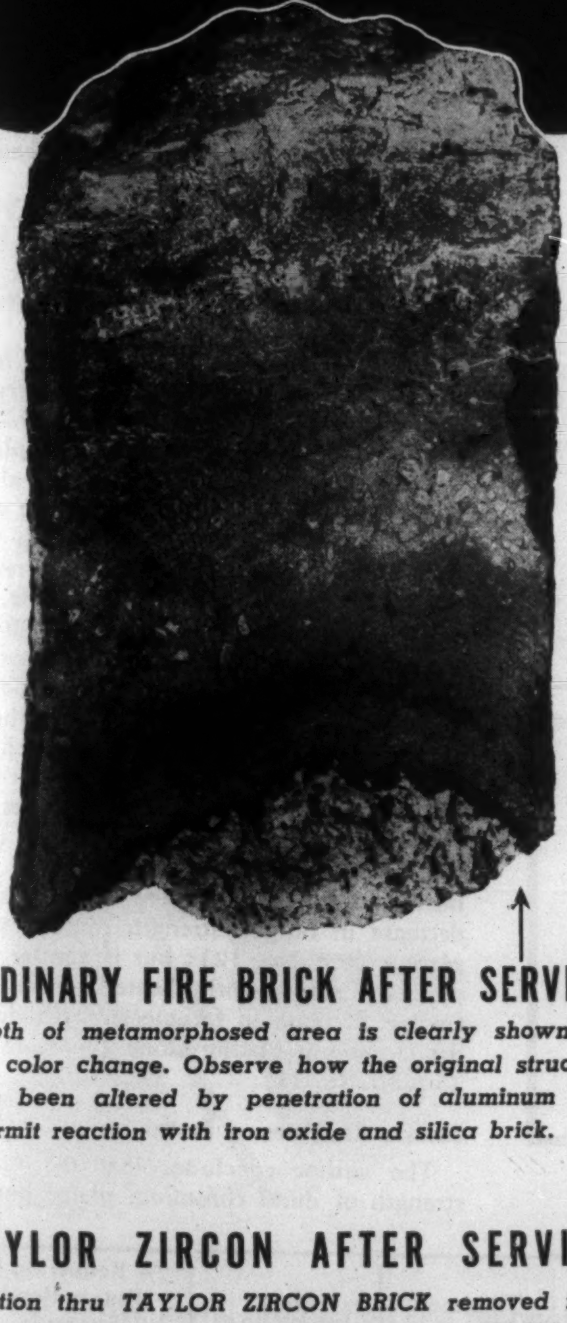
Fisher FURNACE COMPANY

FOR THE ALUMINUM INDUSTRY

Taylor ZIRCON HEARTHS

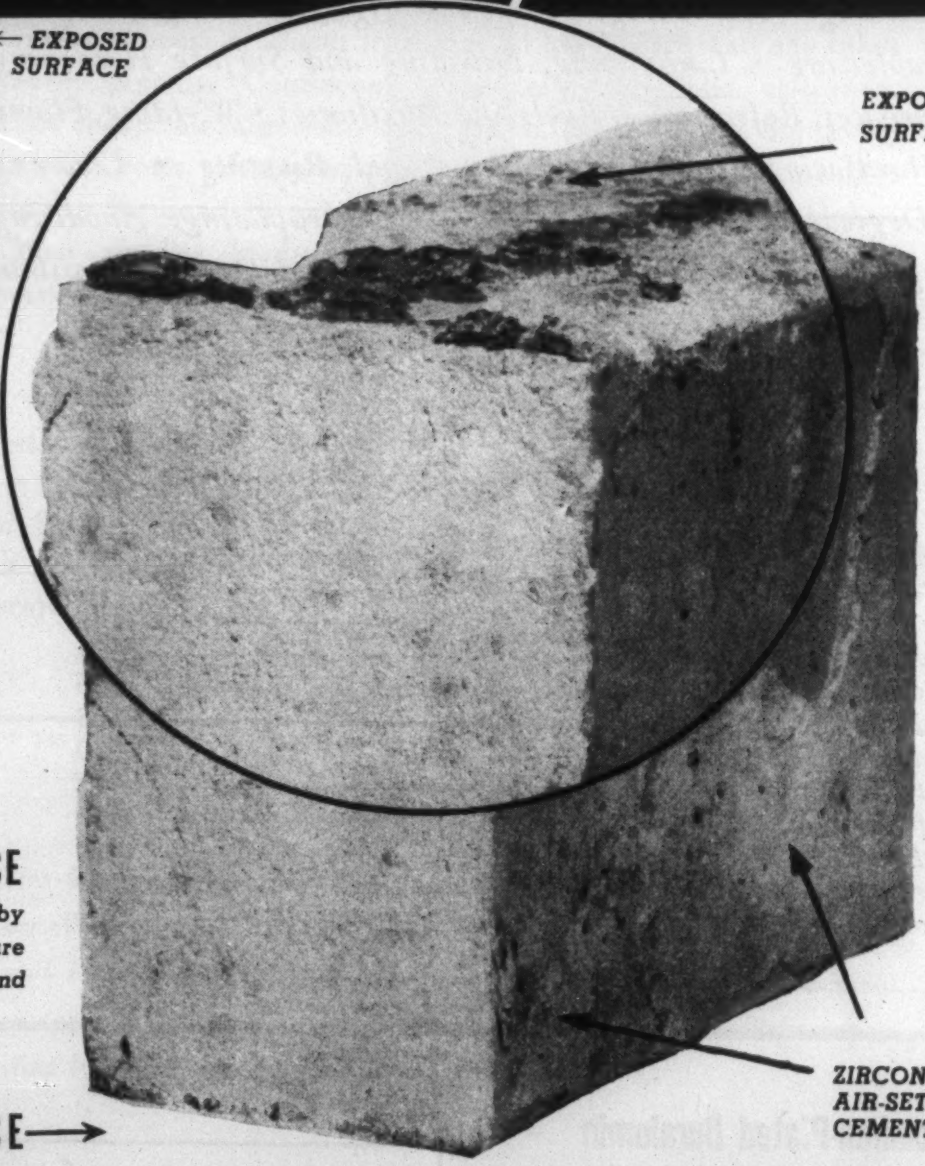
produce cleaner metal

increase production



ORDINARY FIRE BRICK AFTER SERVICE

Depth of metamorphosed area is clearly shown by the color change. Observe how the original structure has been altered by penetration of aluminum and thermit reaction with iron oxide and silica brick.



TAYLOR ZIRCON AFTER SERVICE →

Section thru TAYLOR ZIRCON BRICK removed from hearth of aluminum re-melt furnace. 14,750,000 lbs. melted on this hearth. No penetration.

We think that these illustrations prove conclusively that, if the Refractory Industry ever developed a product which is unequalled, even uniquely fitted for one particular job, TAYLOR ZIRCON is certainly that product, when used for hearth construction in reverberatory type furnace for melting Aluminum.

Properties of TAYLOR ZIRCON REFRACTORIES and other pertinent data are given in Bulletin No. 200. Write for your copy today.

TAYLOR

TAYLOR PB SILLIMANITE

CHAS. TAYLOR SONS Co.

MANUFACTURERS OF REFRACTORIES • CINCINNATI • OHIO • U. S. A.

3

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Chromium-Plated Duralumin

Condensed from "Luftfahrtforschung"

"Hard" chromium plating requires special plating technique. It is formed from a fairly concentrated solution of chromium acid at elevated temperature by the use of a current of about 40 amps. per sq. dm. One per cent H_2SO_4 is added to disperse films formed on the cathode by low valent compounds of chromium and to enable the metallic coating to form. Since only about 15 per cent of the current is required for the chromium deposition, a large amount of hydrogen is liberated at the cathode. Hard chromium plated iron or steel must therefore be heated up to 150 to 200 deg. C. (300 to 400 deg. F.) to drive out the hydrogen. The chromium plate is invariably — even without any heat treatment — covered with a network of hair-cracks.

Light alloys require a special pretreatment. In the case of copper bearing alloys, this consists of: 30 sec. pickling in caustic soda solution at 60 deg. C. (140 deg. F.) followed, without removing the black film of copper, by 40 sec. treatment in a concentrated solution of nickel chloride with additions of boric and hydrofluoric acids. The nickel deposit is removed by nitric acid and the chromium plating is then carried out as usual (no details given on exact composition of above solutions).

Fatigue Values

The fatigue tests were made on wrought dural bars of 6 mm. initial diameter in a rotary bending machine for a maximum of 2 x 10^7 cycles. The fatigue strength is given in terms of the initial diameter and represents the average for 5 to 10 bars. A polished sample had a rotary bending strength of 17.75 kg. per sq. mm. The other results are presented in the Table, below.

The thinner chromium plate was used in tests 15 and 17 because the resulting plate was rough and adhered badly.

Although the initial caustic soda has a deleterious effect on the fatigue strength, the subsequent treatment in nickel chloride not only gives the best surface for plating but also brings the fatigue strength almost back to standard. Chromium plating alone hardly affects the fatigue strength (see tests Nos. 4 and 5), despite the presence of numerous hair cracks in the plate.

However, heating for 2 hrs. at 180 deg. C. (355 deg. F.) abruptly decreases the fatigue strength in approximate proportion to the thickness of the plate. Although the fatigue strength improves when the chromium plating is stripped (test No. 8), yet the heating also diminishes the fatigue strength of the base metal (tests Nos. 9 and 10). If the dural has been heated before plating, there is only a slight decrease in fatigue strength caused by the plating (test No. 12); but if similar samples are subsequently heated, there is a further decrease in fatigue strength due to the chromium plating alone (compare No. 13 with No. 14).

Surface Roughness a Factor

The author concludes that the fatigue strength of dural chromium plated but not

Test No.	Nature of Surface	Thickness of Cr, mm.	Heat Treatment	% Reduction in Rotary Bend Strength
1	Polished	—	———	0 (standard)
2	Pickled NaOH	—	———	15.5
3	Pickled NaOH plus $NiCl_2$	—	———	4.3
4	Cr plated	0.03	———	4.3
5	Cr plated	0.08	———	1.5
6	Cr plated	0.03	2 hr., 180 C	22.5
7	Cr plated	0.08	2 hr., 180 C	35.0
8	Cr plating stripped off in H_2SO_4	0.03	2 hr., 180 C	13.0
9	Pickled in NaOH plus $NiCl_2$	—	2 hr., 180 C	13.0
10	Polished	—	2 hr., 180 C	11.0
11	No. 10 pickled in NaOH plus $NiCl_2$	—	———	13.0
12	No. 10 Cr plated	0.03	———	15.5
13	No. 10 Cr plated	0.03	2 hr., 180 C	21.0
14	No. 10 polished	—	2 hr., 180 C	13.0
15	Pickled NaOH and plated	0.01	———	15.5
16	Pickled, sodium zincate	—	———	8.5
17	Pickled and chromed	0.01	———	11.5

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heat treated is controlled entirely by the roughness of the surface before plating. Heating of the chromium plated dural introduces two further factors affecting the fatigue strength: (1) The heat treatment affects the fatigue strength of the base metal; (2) the chromium plating itself affects the strength of the metal due to the presence of hair cracks in the chromium plate.

—A. Beerwald, *Luftfahrtforschung,* Vol. 18, Oct. 27, 1941, pp. 368-371; translated by L. J. Goodlet, *Sheet Metal Ind.,* Vol. 16, Dec. 1942, pp, 1889-1891; Vol. 17, Jan. 1943, p. 68.

Welding Certain Ferrous Metals

Condensed from "Welding Journal"

While the welding of mild steel and cast iron has been described frequently, wrought iron, high carbon steel, and cast steel have received less attention. They are in common daily use, however, and their welding is of importance in reclamation and maintenance work.

The first step is to identify the metal. If the information cannot be obtained from the manufacturer the spark test, chip test, or blowpipe test may be used. Frequently the part itself, and its use, will be sufficient. The medium carbon steels, high-alloy or low-alloy steels, or N.E. steels are, from a welding technique standpoint, classed as high carbon steels.

Wrought Iron and High-Carbon Steel

Wrought iron, a mixture of high-purity iron and an oxide-silicate slag, possesses a fibrous structure due to this slag. Since the iron metal melts at about 2750 deg. F. and the slag at 2100 to 2200 deg. F., the greasy appearance of the metal, the signal of fusion in most metals, means only that the slag is melting. More heat must be applied to fuse the iron.

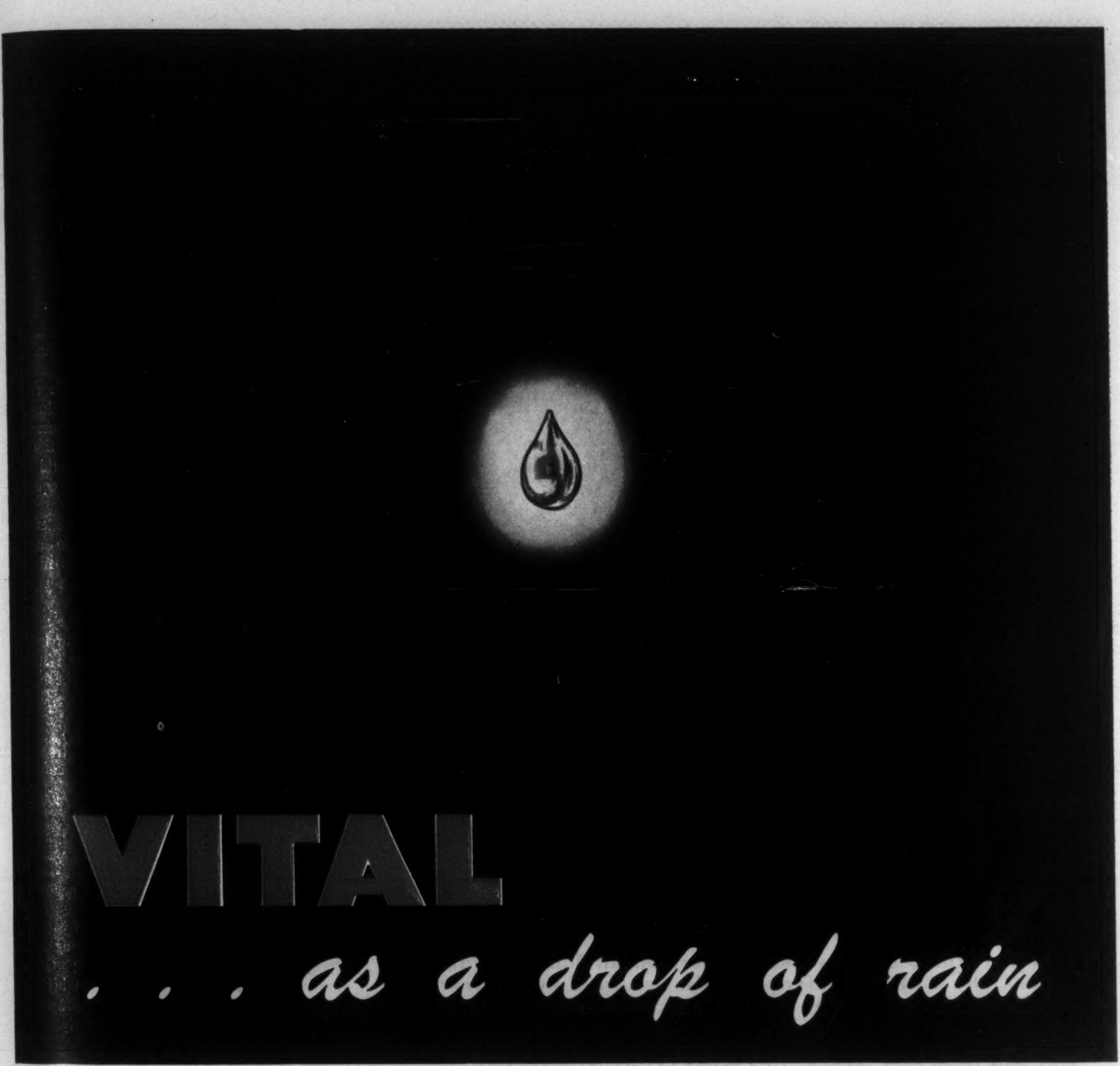
The oxyacetylene process, using a neutral flame and a high-test steel rod, with as little puddling as possible, gives good results. Plate or pipe one-half in. or more in thickness should receive more than one pass. A slight excess of acetylene is recommended for welding all-wrought iron piping.

From the standpoint of oxyacetylene welding, steel containing over 0.70 per cent carbon is considered high carbon. It is important to obtain a knowledge of their properties and heat treatment, and to have available the heat treating equipment required, before attempting to weld. Parts made from these steels are usually heat treated, and the reproducing of this treatment is sometimes beyond the facilities of the weld shop.

It is usually desirable to preheat these steels. Welding should be done with an excess acetylene flame, and just enough heat to obtain fusion. For relatively thin parts a rather low carbon rod with alloy additions can be used, while for heavier sections or parts to be heat treated, a higher carbon rod, such as a chrome molybdenum rod, is recommended.

Steel Castings

Steel castings are easily welded by using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Spirit . . . . Our enemies, who lack among their own peoples an idealism that motivates the individual from within rather than one forced upon him, are increasingly learning to count the cost of their gross ignorance and accordingly miscalculating that tremendous VITAL force – AMERICAN SPIRIT! Just as American Spirit is helping forge victories on the field of battle, so does American Spirit on the production front provide the priceless ingredient which, added to materials and skills, results in our unprecedented output.

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the normal steel welding procedure. Broken castings should be carefully examined for distortion and any heating and bending done before welding. Small castings require no preparation other than beveling the edges to be welded. Larger castings with thick walls, or of such a design that localized heating might set up strains, should be preheated to bright redness. Welding should be done in a series of overlapping layers. Sand holes or other dirt should be carefully worked to the surface. A neutral flame and high-test rod should be used.

Two special types of work occur frequently on castings, (1) building up lugs, gear teeth or edges, and (2) filling holes. In building up lugs, etc., care must be taken to get thorough fusion as the first layer is applied. The flame is drawn back a bit if the metal appears to become too fluid. To fill holes extending all the way through the steel, the hole should be countersunk or fused down to the equivalent of countersinking.

Welding is begun at the bottom edge and added progressively around in narrowing circles until the hole is closed at the bottom. Metal is then added a layer at a time until the hole is filled.

When the hole extends through a thick section, it may be countersunk from both sides and a plate of one-eighth inch steel inserted at the narrowest point. The hole is then filled as before, first on one side, then on the other.

—H. R. Morrison, *Welding Journal*, June 1943, pp. 418-420.

Gun Tubes from Seamless Tubing

Condensed from "The Iron Age"

A new way of making heavy gun barrels (75-mm.) from seamless steel tubing has brought Timken Roller Bearing Co.'s monthly output of heavy guns to a higher level than all of England's heavy gun output during the entire war. Formerly such gun tubes were forged.

Bars of steel (84-in. dia.) are first slowly rolled by gravity down an inclined platform and hearth to the bottom of the piercing mill furnace. The 1400-lb. bars are pushed out of a side door at the lower end of the furnace onto a gravity conveyor that takes them to the piercing mill.

The bars are then pierced, the operation requiring 15 seconds. This compares with a required time of 6 hrs. by the former forging and drilling method.

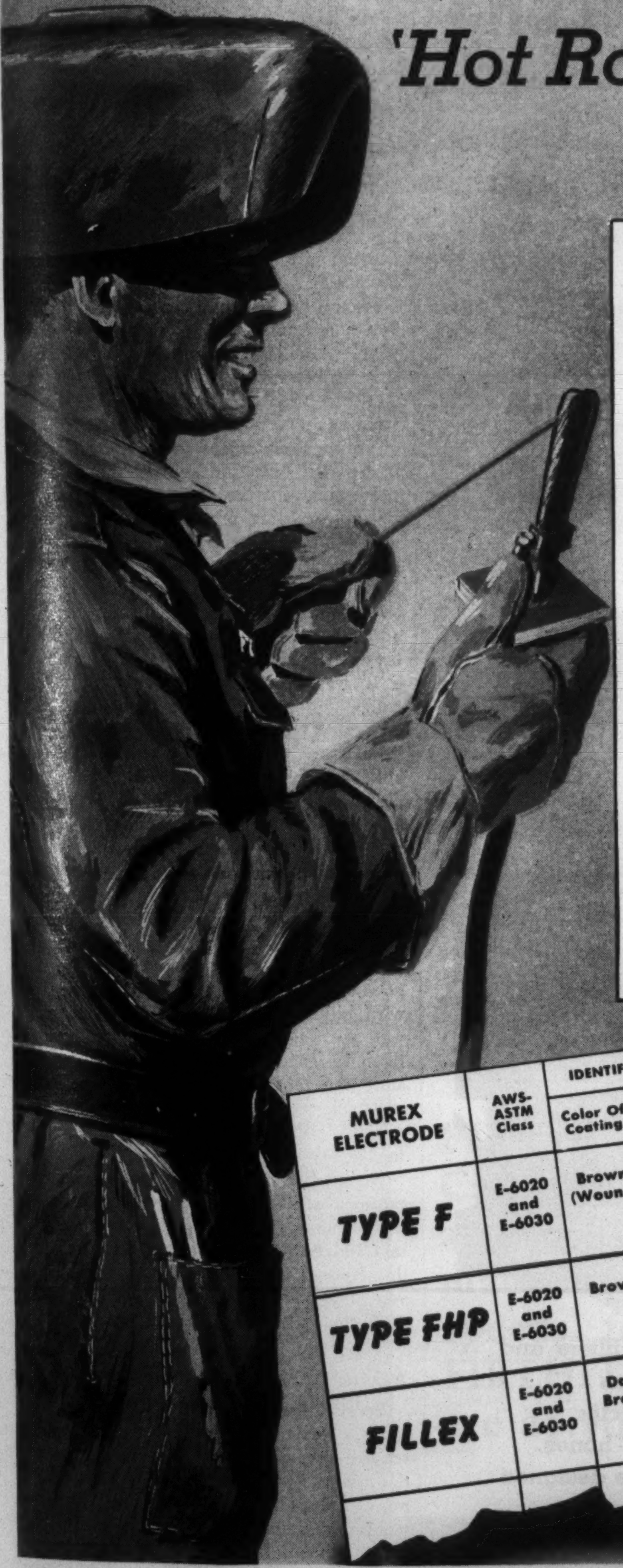
After piercing the gun tube is rapidly sent through a rolling mill. The inner walls are further smoothed and the tube re-rolled to greater accuracy.

To save steel the tubing is made to the diameter of the gun tube and not to that of the breech, as formerly. The breech is formed by heating the end of the tube in an induction furnace and then upset-forging the breech.

The heat treating system for the tubes is conveyorized. One production line is able to handle 6000 75-mm. tubes a month.

After water-quenching the tubes are pickled, and marked with code numbers and mill data. A ring of steel, from which

"Let me tell you about these Murex 'Hot Rods' for mild steel"



"Murex Type F and Type FHP are my choice for horizontal and flat fillet welding, deep groove work, cover beads and other down-hand work. I find both electrodes alike in performance and quality of the weld metal—except that the spiral winding of asbestos yarn on Type F makes it possible to bend the rod without injuring the coating when I have to weld in hard-to-get-at places.

"I use Fillex mostly for horizontal fillets. The weld metal forms well up the vertical leg and it's easy to turn out fillets of equal leg dimensions at high speed and without undercutting.

"All of these rods will take plenty of heat and have good penetration. The welds are smooth, and, as you can see from the table below, have good physical properties. The slag is very easy to remove.

"I find the new M & T Murex Electrode Chart a big help. It tells you when to use each Murex electrode, gives its physical properties and illustrates six ways of improving welding practice.. You can get a copy by writing Metal & Thermit or asking your distributor."

MUREX ELECTRODE	AWS-ASTM Class	IDENTIFICATION		Current	POLARITY		TENSILE STRENGTH OF DEPOSIT		ELONGATION OF DEPOSIT IN 2"	
		Color Of Coating	Color On Tip		Groove Welds	Fillet Welds	As Welded (p.s.i.)	Stress Relieved (p.s.i.)	As Welded %	Stress Relieved %
TYPE F	E-6020 and E-6030	Brown (Wound)	Blue	A. C. or D. C.	Reverse	Straight	62,000 to 69,000	60,000 to 67,000	25 to 31	30 to 36
TYPE FHP	E-6020 and E-6030	Brown	Blue	A. C. or D. C.	Reverse	Straight	62,000 to 69,000	60,000 to 68,000	25 to 31	30 to 36
FILLEX	E-6020 and E-6030	Dark Brown	Blue	A. C. or D. C.	Straight	Straight	62,000 to 70,000	60,000 to 69,000	25 to 30	30 to 33

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are prepared test specimens, is sawed from each tube and sent to the laboratory. Tubes are sent to a government arsenal for finishing.

—A pictorial article, *Iron Age*, Vol. 152, Aug. 12, 1943, pp. 74-77.

New Electrodes for A.C. Welding

Condensed from "Steel"

Production for war has stimulated the welding industry as much if not more than any other fabricating group. Difficulties resulting from neophyte welders, layer-outs and fit-up crews have been increased by direct-current welding, in which magnetic blow is the primary headache. Alternating-current welding solves this problem.

When tried during World War I, a.-c. welding was not successful, due to lack of proper electrodes. The introduction of coated electrodes with outstanding properties, in the 1930's, was the real start of welding progress. Clean, gas-free welds were possible in flat, vertical or overhead positions. Attempts to speed welding in the flat position caused spatter at the high current densities required, and the "hot" rod was developed to overcome this.

It was recognized that a "cold" electrode, with not quite so outstanding properties, was desired for general purpose work, and such a rod was available by the mid-30's. The all-position electrode did its best work in 1/8, 5/32, and 3/16-in. diameters, while the "hot" rod was used where larger sizes were required.

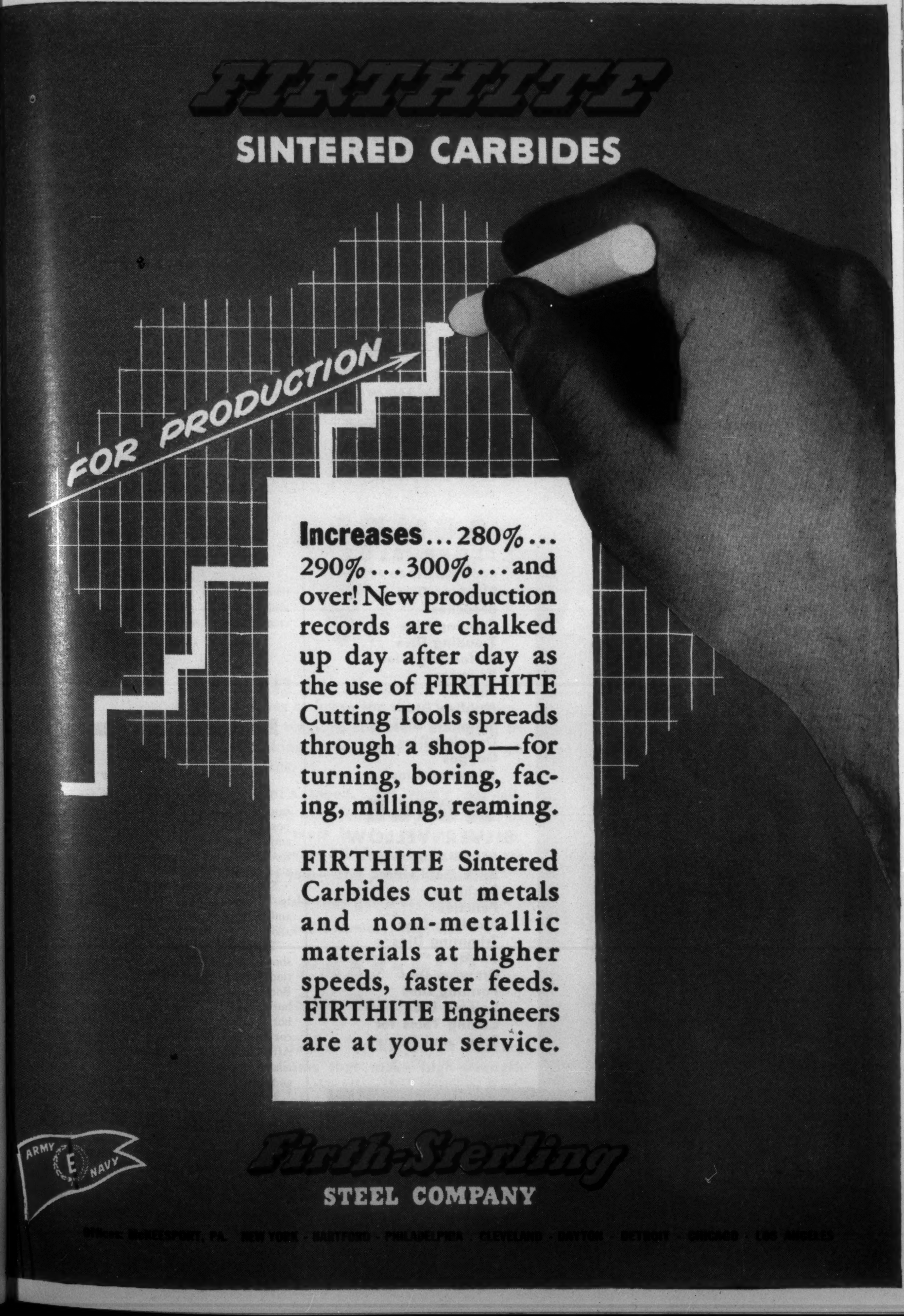
The all-position electrode was a direct-current, reverse-polarity electrode which gave considerable spatter with straight polarity or alternating current. The flat-position electrode, however, could be used with either polarity, and proved to work well with a.-c. General purpose electrodes likewise gave pleasing results with a.-c., and since then it has been learned that most electrodes that perform well with straight polarity are suited to a.-c. welding.

Acceptable a.-c. welding transformers became available, and heavy construction, with troublesome corners, and pressure vessels and boilers became a natural field for this type of welding. However, no quality vertical or overhead welds were possible with the rods then available.

A.C. vs. D.C.

Because the current returns to zero many times a second, electrodes for a.-c. welding require greater arc stability than those for d.-c. work. The same thing that determines the polarity of an electrode in d.-c. welding is responsible for its behavior with a.-c.—its chemical composition. The primary difference between a.-c. and d.-c. electrodes is found in arc-stabilizing materials present in the coating.

With the coming of World War II, the a.-c. welding process was pushed by WPB because the machines were easier to build and required less strategic material. The a.-c. units were also more efficient, and



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consumed almost no current when idle, while the d-c. motor-generator set has appreciable current demand when running idle.

A considerable portion of the war demand for electrodes is in the shipyards, where much vertical and overhead welding must be done. After intensive development work, two all-position a.-c. electrodes appeared last year. These electrodes will give the required ductility in 5/32-in. diameters and smaller. Judging by past performances, however, this limit should soon be lifted, and a.-c. welding in the shipyards would become possible in every d.-c. application.

While every mild steel welding job can now be done by either a.-c. or d.-c. methods, there are few electrodes available for alloy steel welding, although without doubt they will be produced in response to demand. Low-alloy high-strength steels can be welded acceptably with d.-c. electrodes, and with a few a.-c. rods.

More are certain to be added to the list. High alloy welding is now done by d.-c. almost without exception, but a trend to a.-c. is inevitable. Non-ferrous welding comes closest to being an absolute d.-c. field, but there are excellent reasons for suspecting a.-c. use here too. Hard-surfacing deposits have been d.-c. products, but a.-c. rods for this work should be available before long.

Elimination of magnetic blow, reduction of repairs of bad work, and lower power demands mean more work with less cost, and provide a powerful incentive for increased use of a.-c. welding.

—Harold Lawrence, *Steel*, April 19, 1943, pp. 98, 126-127.

Phosphate and Oxide Treatments for Steel

Condensed from "The Iron Age"

The primary type of solution for applying phosphate coatings to steel is composed mainly of orthophosphates of iron and manganese, or of orthophosphates of iron and zinc. Sometimes free phosphoric acid is added.

Steel parts will receive a coating mainly of interlocking crystals of secondary and tertiary iron and manganese, or iron and zinc phosphates.

To produce a satisfactory coating in a short time, modifications of the above solutions are used which contain accelerators. Both metallic copper and nitrates are used but nitrates are preferred. By spraying the hot solution on the steel a satisfactory coating can be obtained in 1 or 2 min. After treatment, the parts are thoroughly rinsed in hot water to remove solution and products of reaction.

In most cases it is impossible to rinse solutions from the parts completely, therefore it is recommended that the parts be given a passivating treatment by dipping them, for about 1 min., into a 0.5-1.0 per cent solution of chromic acid at around 180-200 deg. F.

Steel so processed will usually have a gray surface, and probably show brown or tan streaks. These streaks are chromic

Only 60 seconds to braze these 3 rings!

YES SIR, that's all the time it takes to braze the three brass coupling rings to the steel stamping in making these covers for Navy gage boxes.

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Second, they have worked out an automatic set-up which includes *preplacing* the alloy in the form of EASY-FLO wire rings.

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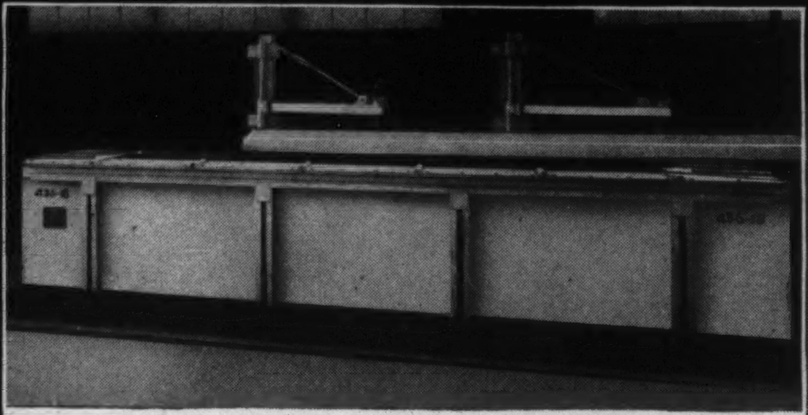

R-S pioneered in the development of Salt Bath Furnaces for the heat treatment of aluminum alloy parts. Some of these installations have been in continuous operation for fifteen years or more.

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acid stains and do no harm. They usually add to corrosion resistance and subsequent paint adhesion.

After drying parts may be dyed black with hot water soluble dye. This will not add to the corrosion resistance.

U. S. Army specification 57-0-2B lists standard salt spray requirements to be met by the various finishes. The applicable salt spray specification is AN-QQ-S-91. Zinc plated parts must not show failure after 48 hr. in the spray. Dry phosphate coatings must withstand 3 hr. and oiled coatings 24 hr. Dry oxide type must withstand ½ hr., and oiled coatings 2 hr.

Phosphate coatings will usually average about 0.0002 to 0.0005 in., depending upon the type of cleaner used. Vapor degreasing and alkaline cleaning gives two different thickness of deposit.

Due to their non-metallic nature, these coatings are poor conductors of electricity. Accordingly spot welding would not be practical.

Oxide coating process consists of boiling steel in a solution of water, sodium hydroxide and various other chemicals. Most of the mixtures giving good results are patented.

After treatment the parts are rinsed in water and oil. Because large amounts of chemicals are dissolved in the water to make up the solution, the boiling point is often as high as 400 deg. F.

The average setup consists of cleaning tank, rinse tanks, hot solution tank, and oil tank. If rusted steel is used, a pickle tank and rinse should be provided.

The film formed is an iron oxide. It penetrates the metal surface 0.00001 in. and causes no dimensional build up. A high luster may be obtained if the parts are polished prior to processing.

—F. Carl Hirdler, Jr., *Iron Age*, Vol. 151, June 3, 1943, pp. 61-62, 128.

Recovery of Nickel from Plating Baths

Condensed from "Monthly Review," American Electroplaters' Society

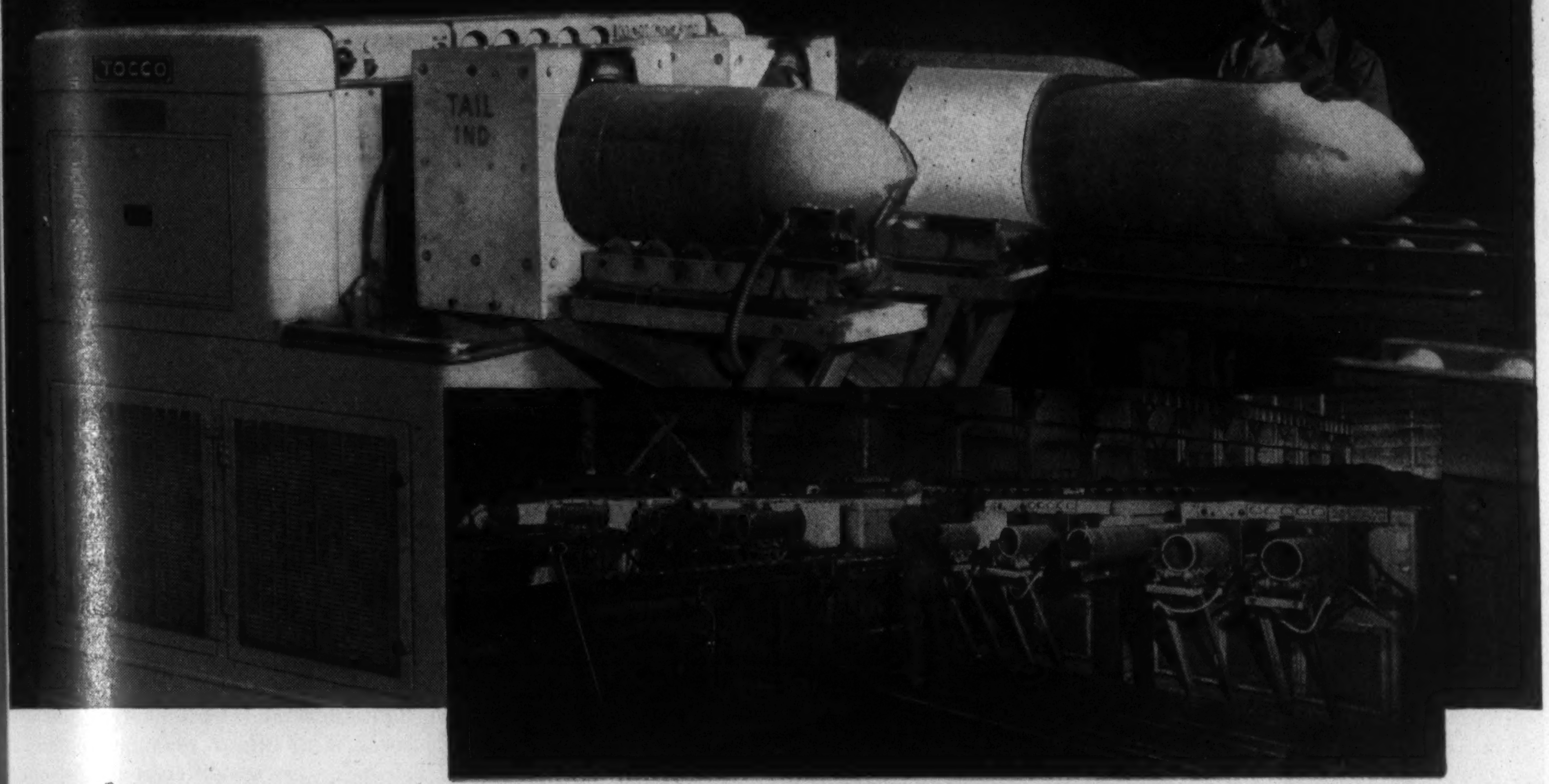
There are in the United States about one million lbs. of nickel as plating salts in solution. Since most of the plating solutions are idle, attempts are being made to recover this nickel in usable form.

Recovery methods considered include: (1) evaporation followed by roasting to nickel oxide; (2) precipitation of nickel carbonate; (3) cementation of nickel on iron; (4) electrolytic recovery of pure nickel using insoluble anodes; (5) recovery of a nickel-iron alloy by electrolyzing with iron anodes.

Consideration of costs, equipment, and material requirements led to adoption of method No. 5. No attempt was made to produce a deposit of good physical characteristics. The pH during the recovery of 942 lb. of nickel from 1900 gal. of solution varied between 2.7 and 5.1.

To obtain a high nickel alloy over most of the process a c.d. of 30 amp./sq. ft. is optimum. To obtain a high nickel alloy in recovering the last 15 per cent of re-

THIS "BOMBARDIER" HITS THE TARGET *EVERY* 49 SECONDS



At Wheeling Steel Corp., batteries of TOCCO machines are really putting the heat on the Axis—heating the ends of pipe to 2100° F. for the spinning of bombs.

One operator, manning two TOCCO machines, each with two inductors, heats tail ends of these "500-pounders" and feeds one to the spinner every 49 seconds.

The heated area of every bomb is uniform. TOCCO's automatic timing assures accurate temperature for uniform forming results.

Yes, it's a fast pace, but the "bombardier" maintains it easily. The push of a button starts each TOCCO station. His "bomb bay" between the four stations of the 7′ wide TOCCO machines is compact. His working conditions are safe and free of fire, heat and fumes.

Just as TOCCO is blasting the Axis in this and hundreds of other war factories, so will it crack wide open many of your tough problems in post-war planning. Find out how these dependable, rugged induction heat-treating machines will cut your costs and improve your products.

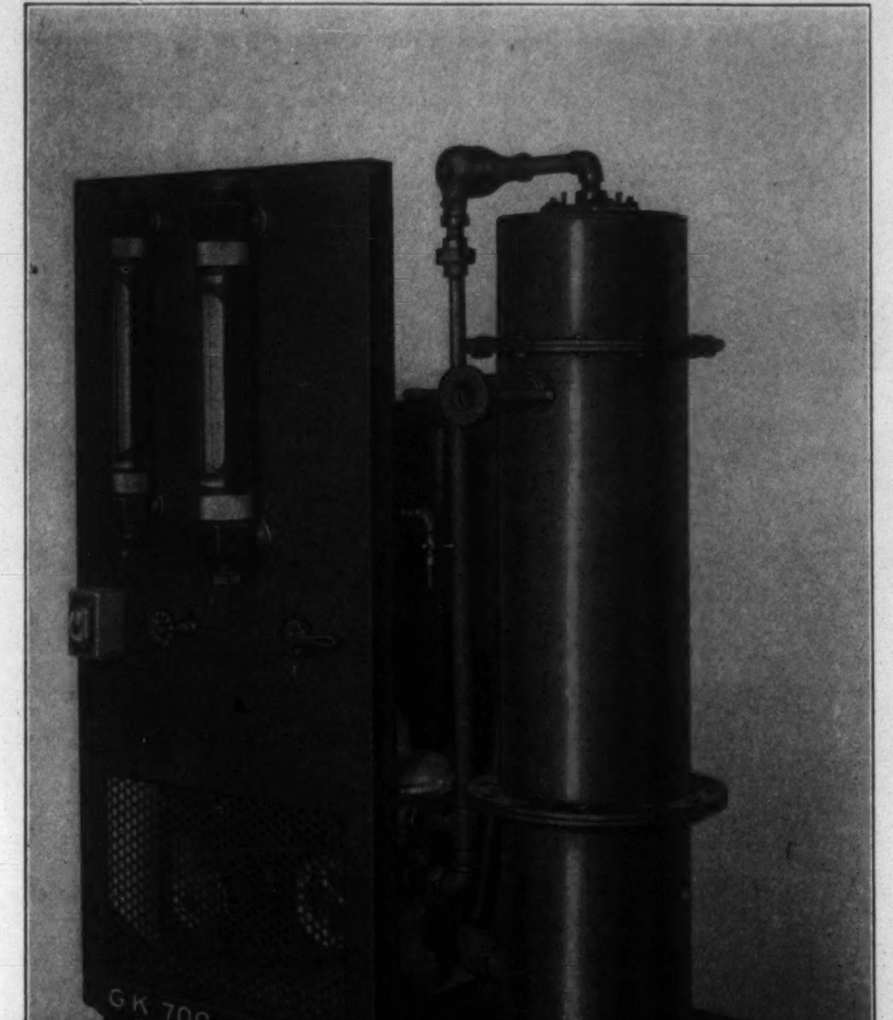
THE OHIO CRANKSHAFT COMPANY
Cleveland, Ohio

JUST PUSH A BUTTON

TOCCO

World's Fastest, Most Accurate Heat-Treating Process

HARDENING
ANNEALING
BRAZING
HEATING for
forming and forging



MODEL GK700 JUTHE GASKRAK

For Selected Heat-treating Atmosphere

ARMY E NAVY

Applied to all types of furnaces.

American Electric Furnace Company
29 Von Hillern St., Boston, Mass., U. S. A.
Industrial Furnaces for All Purposes

coverable nickel a c.d. of about 5 amp./sq. ft. is used at a pH of 5.5, or a c.d. of about 40 amp./sq. ft. at a pH of 4.0. A temperature of 120-140 deg. F. was maintained. The bath was not agitated or filtered.

About 85 per cent of the nickel was recovered, the process becoming too costly and inefficient for recovery of the last 15 per cent. Due to the changing composition of the deposit as electrolysis proceeds, the product is best sold to the steelmaker on a batch basis, each batch containing an amount of nickel determined from loss of nickel from the plating solution.

The cumulative kw.-hr. of power used per lb. of nickel recovered was 4.95, based on generator output. The total deposit weighed 1621 lb. and contained an average of 58 per cent nickel. 1828 lb. of iron anodes were dissolved. A procedure for determining nickel in the presence of iron is given.

—Walter L. Pinner, *Monthly Rev.*, Am. Electroplaters' Soc., Vol. 29, 1942, pp. 823-830.

Hardening Titanium Steels

Condensed from "Archiv Eisenhüttenwesen"

The system iron-titanium-carbon has two carbides, the easily soluble Fe_3C and the difficultly soluble TiC. The former disappears when the ratio Ti:C = 4 (atomic ratio) is exceeded.

The solubility of TiC seems to change with the carbon and titanium contents of the steel. With higher titanium contents, TiC can occur in two different forms, one primarily precipitated coarse, and one finely distributed, precipitated from the γ-Fe.

The hardenability of unalloyed steels in water-quenching is lowered by titanium additions by the binding of carbon to difficultly soluble special carbides and the nucleus effect of the carbide combinations. In steels with 1 per cent C, this reduces the penetration of hardness, especially at high temperatures.

For moderate cooling velocities, *e.g.* in air, the hardenability can increase in titanium-containing steels, especially at higher temperatures, if the titanium carbides have partly dissolved. The finely distributed incorporations of titanium carbides cause a high insensitivity against overheating by impeding the grain growth.

The mechanical properties of titanium-containing, but otherwise not alloyed, steels depend in the rolled and forged condition on the temperature of hot deformation, and in normalized condition on the annealing temperature. Increasing annealing temperature in normalizing increases mechanical strength but this cannot be used practically because it is accompanied by a comparatively strong decrease of notch-impact toughness.

Other Additions

Titanium additions to nickel hardening steels with 2.5 per cent Ni also reduce hardenability, which is compensated for only by hardening from higher temperatures (due to the dissolving of car-

et's get on with the war

..AND SPEED THE AMMUNITION

with

PENNSALT CLEANERS!

Reg. U. S. Pat. Off.

Let's keep hitting the Axis with everything we've got! If you have a metal cleaning operation, let us show you what a Pennsalt Cleaner can accomplish in getting it done in less time—or at less cost—or with more output.

Take this case for example: A well-known steel company was producing 0.30, 0.50 and 0.55 calibre cups for bullet jackets. Involved was a continuous washing, annealing, quenching, pickling and rinsing process. The components were carried through a perforated shell partly submerged in the cleaning solution.

When the Pennsalt serviceman called, he found that the cleaner then in use was only partly effective. Unsaponified oil was burning off in the annealing furnace, creating smoke and soot—and because the perforations in the shell became clogged, there were repeated delays due to cleaning difficulties.

When a fresh solution of Pennsalt Cleaner was used in the tank at one ounce per gallon concentration—*delays and cleaning difficulties stopped at once!*

Let our experienced technicians help you with *your* metal cleaning problems. Actually billions of cartridge cases, shell cases and bullet jackets—as well as great quantities of other ordnance and armament—have been most successfully cleaned with Pennsalt Cleaners.

Consultation involves no obligation. Write fully—Dept. MA.

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ANUFACTURING COMPANY
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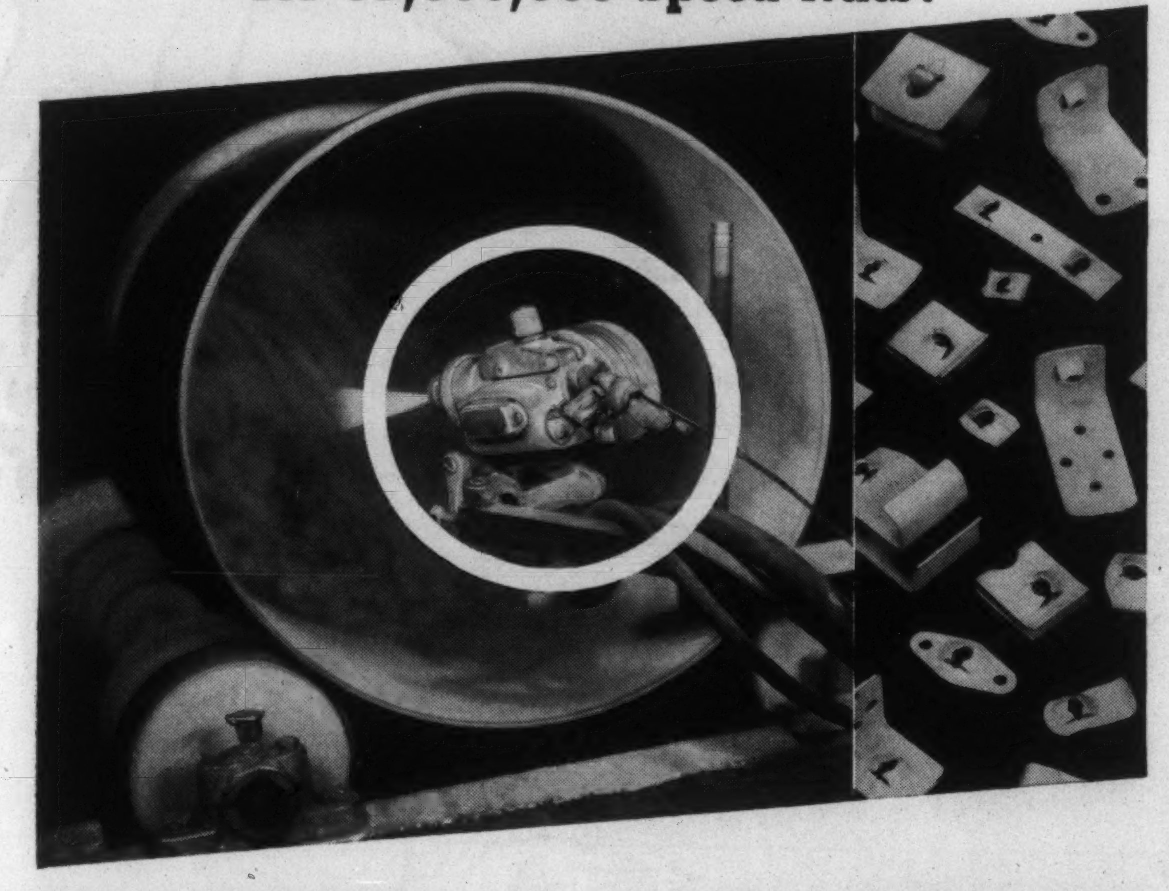
ew York • Chicago • St. Louis • Pittsburgh • Minneapolis • Wyandotte • Tacoma

Super-Speed Coatings

for 65,000,000 Speed Nuts!



Your METCO Metallizing Guns can protect small parts, too

ONLY THE METCO Type 2E Metallizing Gun is equipped with the Power Control Governor. Built into the turbine, it automatically controls and stabilizes wire feed at *all* speeds . . . eliminates gear changes... avoids obsolete needle valve control which restricts air flow and reduces power at low speeds. For maximum efficiency and economy, insist on the Power Control Governor. Write for Bulletin 42A.

IS RUST-PROOFING a factor in your product finishing? Are present methods too slow, too costly, or inadequate? By replacing plating and painting with METCO Metallizing, Tinnerman Products, Inc. has to date produced 65,000,000 aircraft Speed Nuts at higher speeds and with greater corrosion resistance than ever before.

Cadmium plated nuts required baking for 20 hours, to avoid hydrogen embrittlement. A special painted finish could not be used because of its insulating characteristics. But sprayed zinc eliminated all former difficulties. Applied automatically in revolving baskets—by 4 METCO Guns, coatings are completed in minutes! Whereas plating failed after 250 hours in salt spray tests, metallized zinc withstood 350 hours!

From tiny fittings to huge shafts, METCO Metallizing Guns (*one model for all metals*) are keeping products of every type and size in service longer. Write for details and your copy of METCO NEWS.

METALLIZING ENGINEERING COMPANY, INC.
38-14 30th Street Long Island City 1, N.Y.
In Canada: B. W. Deane & Co., Ltd., Montreal

TEN YEARS OF PROGRESS

METCO
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WORLD'S FINEST METALLIZING EQUIPMENT

bide); this treatment also produces a better retention of temper. In contradistinction to the unalloyed steels, nickel steels have a comparatively high ratio of elastic limit which increases with the titanium content.

Chromium steels with titanium additions require higher hardening temperatures than vanadium containing steels, they remain softer and have low temper-permanence. For the same heat treatment, the vanadium steel has a higher elastic limit and tensile strength.

Higher hardening temperatures cause for both additions an increase in those properties that are greater with titanium, and therefore makes the chromium-titanium steels equivalent to the chromium-vanadium steels at high hardening temperatures. The hardening over the section was better in the chromium-vanadium than in the chromium-titanium steels. Titanium additions in tool and rapid-cutting steels reduce hardenability and permanence of cutting edge as compared with vanadium additions, but the sensitivity against overheating is noticeably diminished in all steels.

—E. Houdremont, F. K. Naumann, & H. Schrader, *Arch. Eisenhüttenw.*, Vol. 16, Aug. 1942, pp. 57-71.

Controlled Atmospheres in England

Condensed from "Metal Treatment"

Since the early 1920's electric furnaces have attained a high degree of development in England and are now in general use. There have been corresponding improvements in the gas, oil and solid-fuel fired furnaces so that they now give excellent results from the point of view of temperature control.

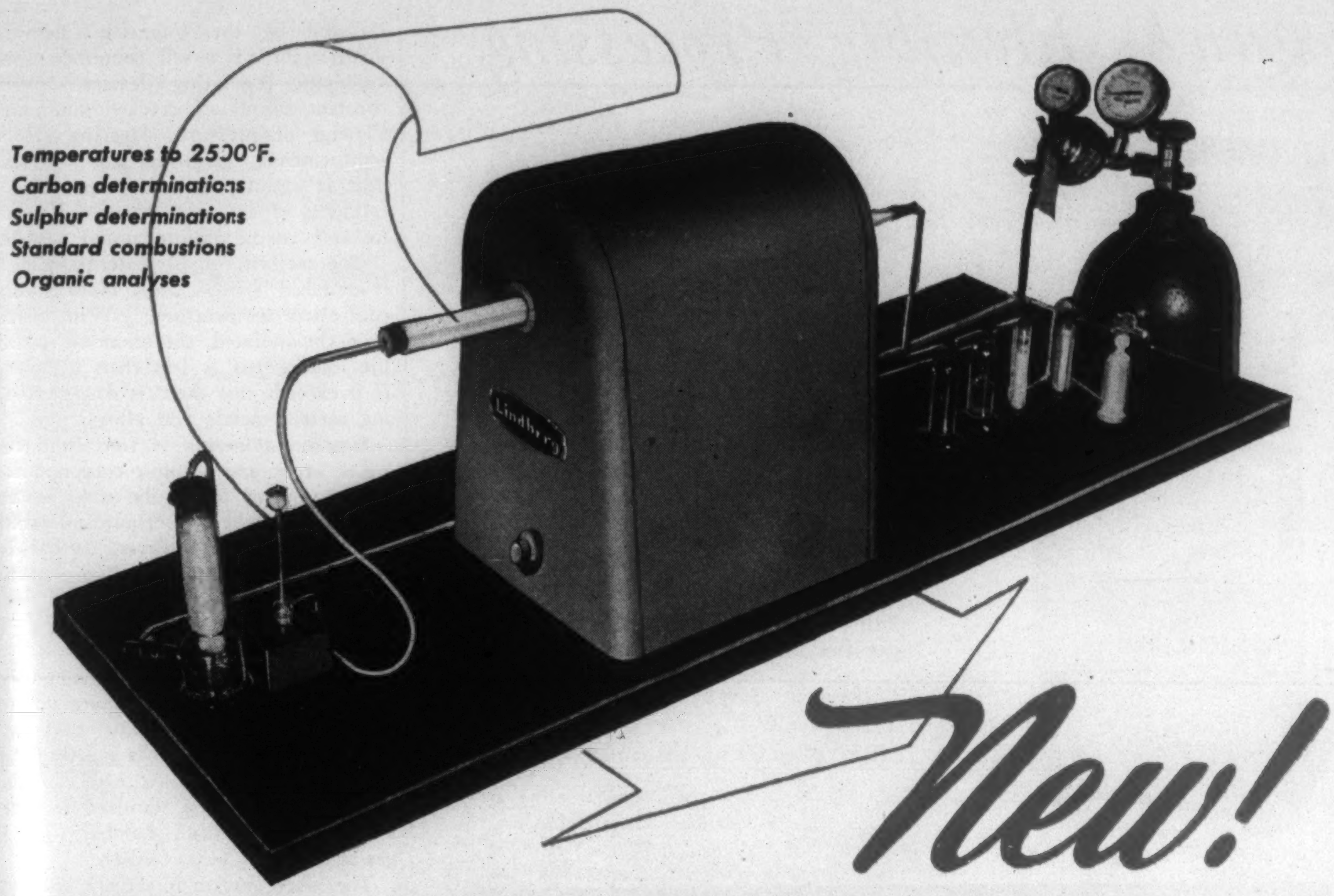
In one of the most successful, the radiant-tube furnace, the mode of heating approximates very closely that of electric-resistance furnaces. The products of combustion do not enter the furnace chamber so that complete control over the atmosphere in contact with the charge is possible as it is in an electric furnace.

Bright-annealing and many other processes depend on the proper control of atmosphere in the furnace chamber and the successful and economic utilization of the atmosphere is largely a function of furnace design. Therefore, electric furnaces, which afford an opportunity for variety and freedom of design, are very suitable for such use.

Most of the atmospheres formerly used, such as steam for bright annealing copper or raw city gas for mild steel, were actually *artificial* atmospheres rather than controlled. Their main function was to displace the air and thus reduce or eliminate oxidation. However, even though this is done, unless the composition of the air is controlled, the heat treatment process may be generally unsatisfactory.

Ammonia Derivatives

"Cracked" ammonia (anhydrous ammonia split into its constituents) contains 75 per cent hydrogen and 25 per cent nitrogen. The cracker designed and manu-



Combustion Tube Furnace

Lindberg presents a NEW, precision controlled Combustion Tube Furnace with temperatures up to 2500°F. in use for the new, 2 minute volumetric method of carbon and sulphur determinations, standard combustion, organic analyses, etc. The high temperature range is equally applicable and desirable for gravimetric carbon and sulphur determinations, especially on high alloy steel.

LINDBERG

Well-known Throughout the World as the Leaders in Developing and Manufacturing Industrial Furnaces

ARMY E NAVY

LINDBERG ENGINEERING COMPANY
2450 WEST HUBBARD STREET, CHICAGO 12, ILLINOIS

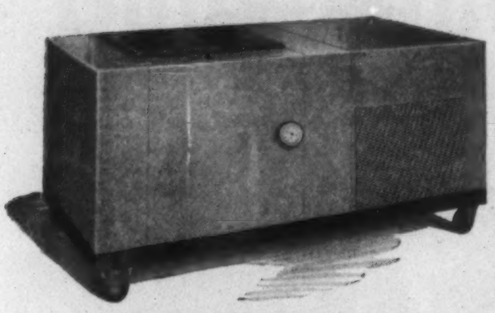
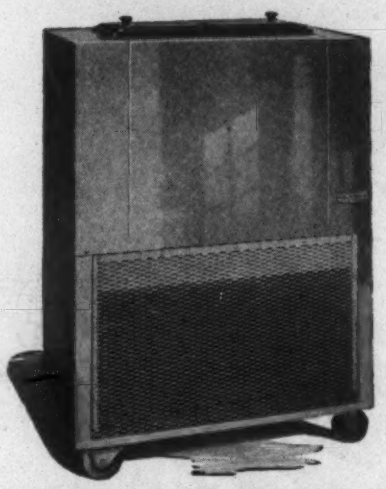
This sturdy unit is constructed of courses of high temperature fire brick and insulating slabs encased in a heavy sheet steel shell. All wiring and terminal connections are fully covered and are easily accessible for maintenance.

The furnace shown above has a heating chamber 1⅜" diameter by 12" long. Low voltage, high temperature type Globar elements are employed for maximum temperatures of 2500°F. and the heat is regulated by a built-in, variable voltage transformer with a power input of 1500 watts. These furnaces are complete with indicating pyrometers.

Like all other Lindberg Laboratory Furnaces, the clean streamlined shape of the Combustion Tube Furnace contributes to the high standard of laboratory cleanliness.

Write or phone your regular laboratory equipment dealer for further information. He will be glad to serve you.

SOLD EXCLUSIVELY THROUGH LABORATORY EQUIPMENT DEALERS



Quick, Flexible Processing

5.4 Cu. Ft. 32" x 34⅞" x 63$\frac{11}{16}$"

2.0 Cu. Ft. 48" x 24⅛" x 34⅛"

Forced aging of metals is one of American Industry's major production victories. . . . Maintaining cold temperatures for quick-aging metals, securing expansion fits and storing materials, is one of KOLD-Hold's contributions to modern high-speed production.

Kold-Hold's Industrial Sub-Zero machines are so flexible that the exact number of possible applications is not known.

But we DO know that these Kold-Hold units perform with high efficiency. They are sturdy, compact, self-contained, cold processing units.

If cold temperature is what YOU need — write for authoritative processing information.

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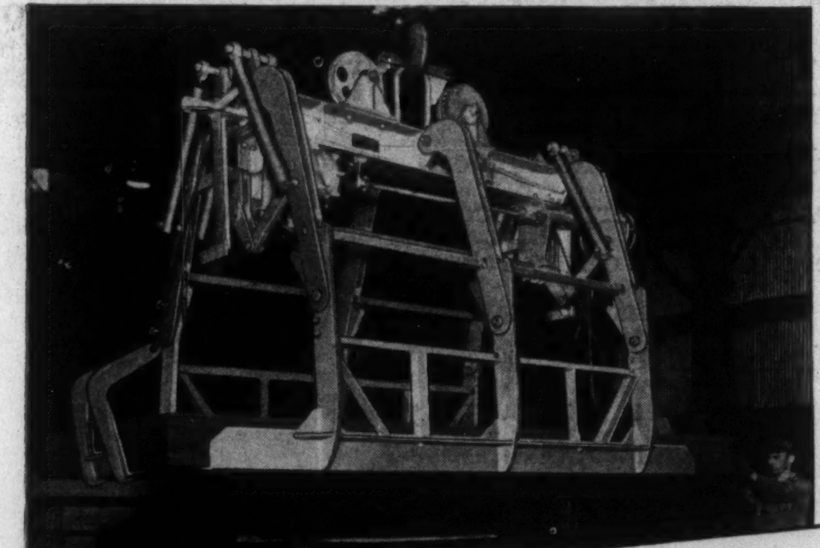
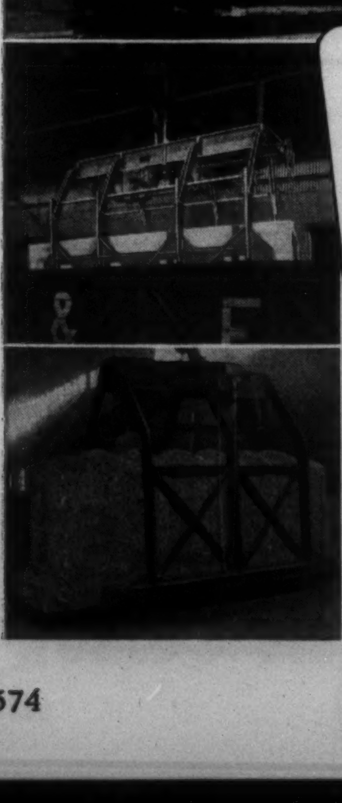


Handle the largest and thinnest sheet stock easily and safely

With a C-F Sheet Lifter 1 man can handle the thinnest stock or longest strips quickly and easily—can pick up loose or bundled sheets, carry them safely and stack them closer and higher without slipping or sliding, bending or kinking, without denting or rippling edges.

C-F Sheet Lifters are made in a wide range of sizes and types; for any cranes, monorail or hoist; for any headroom or working situation; in capacities from 2 to 60 tons. All have patented "elbow" arms. All are accurately balanced and counterbalanced and are easily operated by 1 man . . . with hand chain or motor control.

Write for Bulletin SL 21.

CULLEN FRIESTEDT CO.
1314 S. Kilbourn Ave., Chicago, Illinois

factured by the Imperial Chemical Industries, Ltd. is a self contained unit with automatic regulating devices, ensuring a constant supply of cracked ammonia over a range of pressures covering all normal requirements. Delivery for the standard unit is about 180 cu. ft. per hr. Two cylinders of ammonia connected to the inlet side ensure uninterrupted supply.

The catalyst consists essentially of freshly reduced sponge iron maintained at a controlled temperature. With a cracker properly operated, the ammonia content of the issuing gas is less than 0.1 per cent. If it exceeds this there is danger of nitriding certain metals and alloys.

Cracked ammonia is free from oxygen, water vapor and sulphur compounds. For most purposes it can be used instead of hydrogen. It reduces time and labor and its cost is less. However, its use is still very limited, because its cost, compared to pickling for bright annealing, is often prohibitive and because with air it forms an explosive mixture.

Burnt ammonia is cracked ammonia partially burnt with the requisite volume of air to eliminate the explosive risk. The volume of gas produced is greater than that of the cracked ammonia used. Ammonia burners consist of a standard cracker and a separate combustion chamber. The burnt gas is kept free from oxygen.

The water vapor is largely removed by condensation. Silica-gel dryers provide further dehydration. The hydrogen content is usually controlled to between 5 and 15 per cent. This eliminates the explosive risk but the cost is still too high for general bright annealing processes.

An attempt to reduce the cost is represented by a regenerative ammonia burner where the atmosphere is recirculated, the gas being purified and any loss made up. However, the high capital cost can be justified only in large installations.

Other Atmospheres

When a hydrocarbon such as city gas is used for heat treatment purposes, the unsaturated hydrocarbons dissociate with the formation of soot. To prevent this and lessen explosion risks, developments have been directed towards the partial combustion of the gas. All the burners are designed for controlled combustion so that the product is free from oxygen, non-explosive, and such that various constituents are balanced or controlled with respect to the process for which the gas is to be used. Partially burnt city gas may contain carbon monoxide, carbon dioxide and water vapor.

This is the hydrocarbon most readily available in England but butane and propane, which are free from sulphur, have also been used. They are more expensive but as they are used with a much greater ratio of air, the volume of controlled atmosphere produced is greatly increased for each volume of butane combusted.

Wood charcoal, the purest form of carbon readily available, is widely used in controlled atmosphere generators. The products of combustion consist of carbon dioxide, carbon monoxide, nitrogen, and a small quantity of hydrogen and water vapor.

Atmospheres with carbon dioxide of

"THE GRASS IS *Always* GREENER . ."

Need we finish it? . . . "on the other side of the fence."

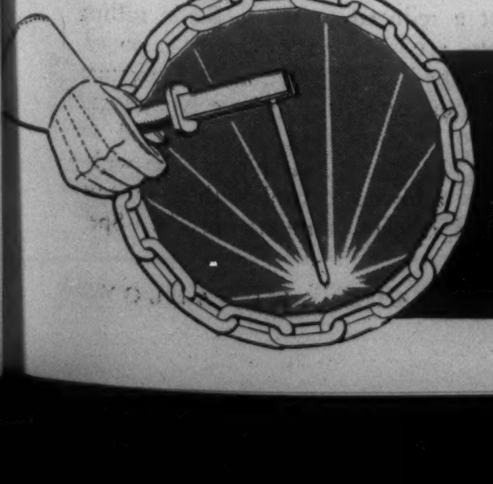
Here at The McKay Company we have no illusions about the very human tendency of most individuals to "shop around" a little in their quest for something better. And because of that deeply ingrained habit The McKay Company and the McKay line of products has grown in importance and reputation and usefulness.

For thousands of buyers who came to "nibble" have stayed to "graze" . . and other thousands, tempted elsewhere for awhile, have returned to the safe, dependable source of recurring satisfactory supply.

If it's stainless or mild steel Welding Electrodes or Commercial Chain you need (Tire Chains, too, although they may not be in your line), the reputation of these McKay products is sustained by 60 years of dependable service to industry

Try them sometime!

Sales Offices: York, Pa.



THE McKAY COMPANY
PITTSBURGH, PA.

WELDING ELECTRODES . . . COMMERCIAL CHAINS . . . TIRE CHAINS

SILVER

BRAZING ALLOYS:

"Readyflow"—56% Silver—works at 1165 deg.
B 201 —20% Silver—works at 1485 deg.
Also many other standard and special compositions.

ANODES:

Of all desired dimensions.

FLUXES:

For use with Silver Brazing Alloys.

Write for booklet "MA"

The American Platinum Works
N. J. R R. AVE. AT OLIVER ST.
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EST. 1875

Metso Cleaners—Good Electrolytes
METSO

● Metso Sodium Metasilicate Cleaners insure baths of high conductivity and stability under high current density. At the same time, the soluble silica content aids in quick removal of grease and oil and prevents dirt from re-depositing on clean work. In a large electro-tinplating plant the use of Metso Granular permits sheet steel to be run through cleaning bath at rate of 1600 feet per minute. Further information on request.

Sodium Metasilicate
U. S. Pat. 1898707

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U.S. Pats. 1948730,
2145749

PHILADELPHIA QUARTZ CO.
Offices: 125 S. 3rd St., Phila. 6; Chicago Sales Off.: 205 W. Wacker Dr.

METSO CLEANERS

between 9 and 21 per cent and carbon monoxide between 20 and 0, are particularly useful for bright annealing low- and medium-carbon steels and can be used for non-ferrous metals and alloys. For high-carbon steels they are decarburizing. For such use the gas may be passed over a heated bed of charcoal to reduce or eliminate the carbon dioxide. It is expected that in the future these burners will be more generally used in England as they are in Europe and America.

Applications

In total tonnage, the bright annealing of mild steel is the most important heat treatment process for which controlled atmospheres are used. Burnt ammonia and burnt city gas are used for both continuous and batch-type furnaces, with a preference for city gas in the latter. This is partly for economic reasons but also because the city gas reacts with carbonaceous compounds so that residues from lubricants on the steel can often be removed. Both atmospheres may be used for the bright normalizing of hot-rolled mild steel.

Burnt city gas as generated is not generally suitable for the bright annealing of carbon steels, but can be used if the temperature does not exceed 1300 deg. F. The products of the charcoal burner are more suitable. For stainless steel, oxygen must be eliminated from the atmosphere so the choice is restricted to cracked ammonia.

The use of controlled atmospheres in gas carburizing is receiving considerable attention at present. The products of the charcoal burner appear to be a good starting point. It is usual to mix the gas with a small amount of hydrocarbon such as butane or propane which must be carefully controlled so as not to form soot.

In the production of white heart malleable iron the white iron castings are decarburized to various depths by packing in iron oxide and heating to 1000 deg. C. for some days. By the use of burnt city gas it is possible to reduce the time to a matter of hours.

Atmospheres derived from ammonia or hydrocarbons are generally suitable for copper as elimination of oxygen is the first requirement. However, excessive hydrogen content will cause embrittlement. With annealing temperatures to 950 deg. F. a hydrogen content of 5 per cent can be used.

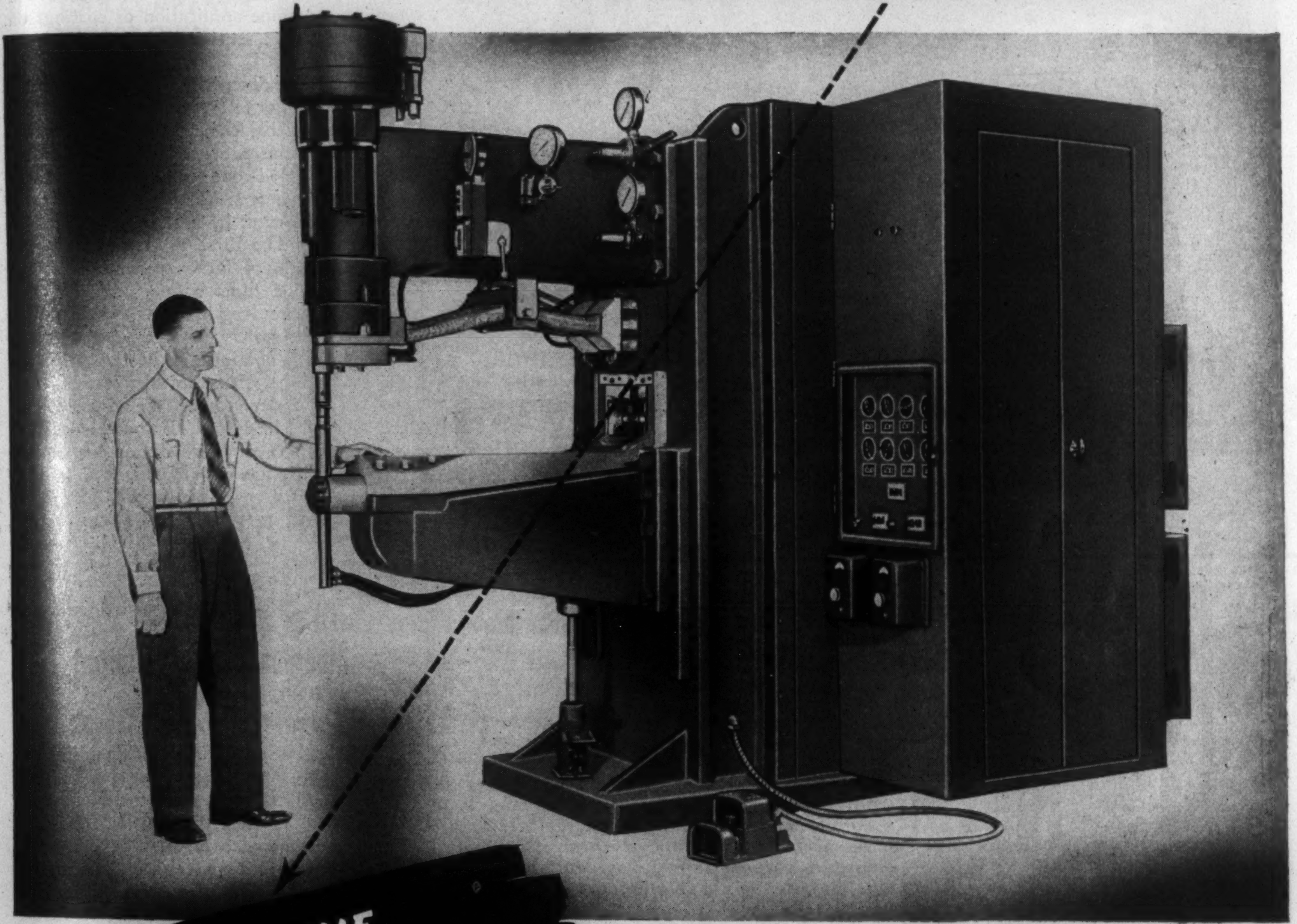
Copper is susceptible to attack by sulphur compounds. These can be removed from controlled atmospheres. To prevent such compounds in the rolling lubricants from staining the copper, steel furnace pots and covers may be coated with a non-ferrous metal.

Cracked or dry burnt ammonia is suitable for the bright annealing of brass. To prevent loss of zinc, the charge may be heated in cracked ammonia up to 750 deg. F under a reduced pressure, while rolling lubricants are drained off and removed. Then cracked ammonia at a pressure slightly in excess of atmosphere is admitted to the pot. Annealing is continued to 1000 or 1100 deg. F., the pot is then withdrawn and allowed to cool with a positive pressure of cracked ammonia inside. Spe-

HELPING TO SOLVE TODAY'S WARTIME PRODUCTION PROBLEMS

★★★

Heavy structural parts on big bombers are now being *SPOT WELDED!*



...ON THE WORLD'S LARGEST SPOT WELDER

THIS HUGE MACHINE, weighing nearly 19 tons, is successfully accomplishing one of the most difficult of welding processes: that of spot welding aluminum and other light alloys in the heavier gauges. Aircraft manufacturers are taking advantage of this development by speeding the fabrication of beams and other heavy structures. In some cases, this process is even efficiently replacing extruded structures.

The 240 KW machine illustrated (Type PMCO.5S-1) operates on the electro-magnetic Stored Energy Principle and incorporates the Sciaky Variable Pressure Cycle. Capacity for aluminum and other light alloys or corrosion resisting steels is thicknesses of from .040" plus .040" minimum up to and including .187" plus .187" maximum. This machine is capable of welding 40 spot welds per minute on two thicknesses of .040" light alloys. Maximum pressure, when both cylinders are operated at constant, 12,000 lbs.

SCIAKY BROS.

Manufacturers of a Complete Line
of A.C. and D.C. Electric Resistance Welding Machines.
4915 W. 67TH ST. • CHICAGO, ILLINOIS

POURING THE HEAT on Hitler's axis

PLAN NOW—
TO SAVE TIME, LATER

Even though war-time restrictions may defer certain improvements involving new equipment, we shall be glad to work with you now on future plans. Some helpful bulletins are available on request.

Keeping steel production at sustained war-time capacity is a punishing test on the durability and efficiency of every piece of contributing equipment. The many Roots-Connersville Gas Booster units throughout the steel industry are faithfully holding up their end of the load because they have always been built to higher-than-ordinary. "R-C" production is dedicated to "making it hot for the axis".

Roots CONNERSVILLE SINCE 1854

ROOTS-CONNERSVILLE BLOWER CORP.
309 Superior Ave. Connersville, Ind.

BLOWERS and GAS PUMPS

Baker Gas Furnaces

TEMPERATURES UP TO 2400° F.
WITHOUT A BLOWER

BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6" x 8" x 5½", to No. 24, which is 12" x 20" x 8" as illustrated. All provide uniform, controlled heat up to 1900° F.

Model No. 5, 6" x 12" x 5", is built especially for treating high speed steel. Gives uniform, controlled temperatures up to 2400° F.

We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½" x 15" x 2½" high.

Special size furnaces built to your order. Write for descriptive folder and prices.

BAKER & CO., INC.
113 Astor St., Newark, N. J.

cially designed pots are necessary.

Nickel-chromium alloys can be considered under the same heading as stainless steels and the "nickel silvers" present the same problems as brass.

—S. V. Williams, *Metal Treatment*, Vol. 10, Summer, 1943, pp. 111-121.

Uniform Films in Dip-Coating

Condensed from "Industrial Finishing"

Differences in film thickness and irregularities in film thickness have long been recognized as one of the principal reasons for complaints on paints and lacquers and for misunderstandings between buyers and sellers. Machine application of coatings on test panels is essential for accurate, reproducible testing.

The author describes a simple apparatus for dip-coating test panels. This instrument is available commercially. It consists of a small constant-speed motor which rotates a stepped-cone pulley having three different diameters. Panels are withdrawn from the dip-tank by a string passing over the pulley. The three rates of withdrawal used, 2, 3 and 4 inches per minute, were found to give films of uniform thickness over the entire length of a 12 inch panel, with a wide variety of surface coatings.

The results obtained in the tests with the dip-coater show that the thickness of coating obtained depends on the viscosity and the rate of withdrawal, if the temperature is constant. Low viscosity or low solids content, and slow withdrawal, lead to thin films.

—H. F. Payne, *Industrial Finishing*, Vol. 19, May 1943, pp. 26-32.

Machinability and Output

Condensed from "Screw Machine Engineering"

The elements affecting machinability are numerous — the material to be machined, the kind of cutting tool material used, the shape of the tool, the cutting lubricant, the type of machine or process, etc.

Changes in tool material and form, lubricants and tool set-up can account for an increase in production of over 1000 per cent. The right coolant alone can make a 30 per cent difference in output and determine the success or failure of the machining operation.

Material Machined

A change in the material machined makes wide differences in power required and permissible cutting speeds. Monel metal requires from 1.8 h.-p. at the tool point to remove 1 cu. in. per min., and has a relative machinability of only 20 per cent, based on Bessemer screw stock as 100. Magnesium, on the other hand, requires only 0.2 net h.-p. to remove 1 cu. in. per min. and has a machinability rating of 1000 per cent compared with Bessemer screw stock.

The average run of carbon and alloy steels requires about 1 h.-p. at the tool

HARDENING CUTTER BODIES *and* HOLDERS *with*

STEWART

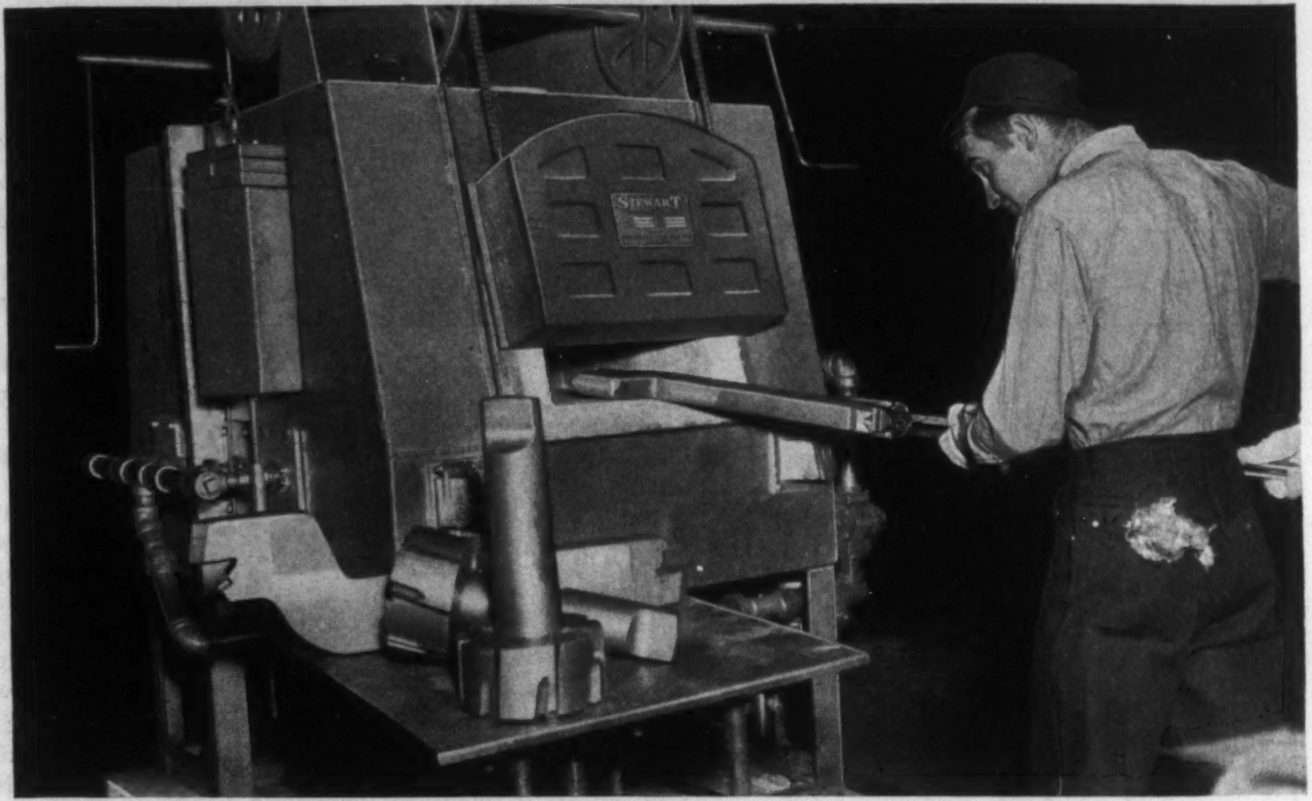
THE BEST INDUSTRIAL FURNACES MADE

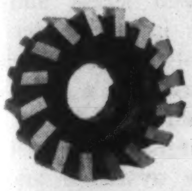
ARMY E NAVY

No. 47 OF A SERIES of Typical Installations

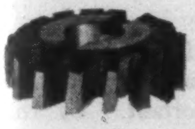
EXAMPLES OF WORK HARDENED IN THE O.K. TOOL COMPANY'S STEWART OVEN FURNACE

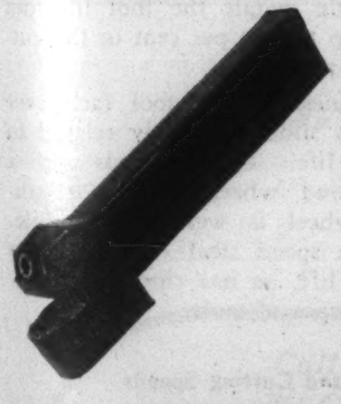
Parts vary in size from 4 inches to 15 inches in diameter and, in weight, from a few pounds up to 100.





The bodies of these milling cutters are heat-treated in the Stewart Special Oven Furnace.





Typical tool holder heat-treated at the O. K. Tool Company.

"Our Stewart Special Oven Furnace is used primarily for hardening cutter bodies and holders," writes Russel Young, Metallurgist at the O.K. Tool Co., Shelton, Conn. "The parts vary in size from 4 inches to 15 inches in diameter and, in weight, from a few pounds to 100 pounds. We can harden three 100-pound cutters in the furnace at one time.

"The patented Stewart Seal-Tite doors at each end of the furnace enable us to use it as a manually operated, continuous furnace. Our work is loaded in the door at one end, pushed along manually, and taken out the door at the other end for quenching. It is fast, economical, and the work comes out clean.

"Considering its size, our Stewart Special Oven Furnace handles an amazingly large volume of work. We estimate that it handles 50% more work than other furnaces of the same floor space. We have not spent one cent on repairs or maintenance to date."

This installation is typical of the industrial furnaces Stewart engineers are building every day to meet the specified requirements of manufacturers all over the continent. In addition to furnaces especially designed to meet specific needs, Stewart also builds a full line of standard-type furnaces.

INDUSTRIAL STEWART FURNACES
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point to remove 1 cu. in. per min. and has a machinability rating of 50-80 per cent of that of Bessemer screw stock. For planing, a series of familiar materials had machinabilities that decreased in the following order (magnesium the most machinable and Monel the least):

magnesium alloy
bearing bronze
aluminum alloy
gunmetal
free-cutting brass
sheet brass
red brass
manganese bronze
cast iron
ordinary brass
malleable iron
SAE 1112, cold drawn
rustless steel
SAE 1315, cold drawn
SAE 1120, cold drawn
SAE 1320, cold drawn
SAE 6140, cold drawn
SAE 3120, forged
SAE 1020, forged
SAE 2320, forged
SAE 2345, forged
copper, annealed
chromium-iron
tool steel (1 carbon)
nickel (grade "A")
Monel

The amount of metal removed varies with the process — *i.e.* milling, drilling, planing, etc. Power requirements for drilling are higher than for turning or planing. Generally speaking, milling requires even more power.

Although long tool life is usually the most important objective, good surface or well-broken-up chips are also frequently sought. These, plus low power, are seldom compatible, so the engineer must select the structure of the metal, the tool-shape, the ratio of feed to depth and the cutting fluid and system for the optimum results.

Free cutting brass and leaded free-cutting steel combine these desirable factors. Low carbon steel produces stringy chips and lowers tool life; it should be machined as-hardened or cold drawn. The use of Bessemer screw stock (B1112 or B1113) increases permissible cutting speed 20-40 per cent, or at the same speed increases tool life 500 to 1000 per cent.

Medium carbon steel, hot-rolled or annealed, machines better than similarly-treated low-carbon steel. The medium carbon grades machine equally well, whether hot or cold finished. Cold-drawn high-carbon steels (over 0.45 per cent C) should be annealed for best machining.

Higher carbon steels produce the longest tool life when spheroidized and the best finished when sorbitic. Hardness of the steel reduces the cutting speed almost directly as the hardness is increased.

Tools and Tool Materials

Of all factors, the material of the tools has the greatest influence on production. High carbon tool steels are still used as finishing tools and on free-cutting metals, but the modern standby is forged and heat-treated high speed steel.

Tungsten high speed steels and moly high speed steels are in use under WPB control. Of the molybdenum steels two grades are most popular — a 5.5 W, 4.5 per cent Mo type and a 9 Mo, 1.5 per cent W variety. Coarse-grained cast high-speed steels are now available and well worth investigating in comparison with forged and heat treated types. Cast alloys of the Stellite type are also used for special jobs. Cemented carbide tools have heavily increased in use.

The use of tipped tools is an important conservation measure. The form of the tool is also important. By changing the side cutting angle alone when cutting uniform, ductile metals the tool life can be increased up to 500 per cent or the cutting speed 50 per cent.

The smoothness of the tool face over which the tips slide is directly related to increased tool life. Lapping tools with a 220-grit diamond wheel or a 320 silicon carbide wheel is well worth while. Nitriding high speed steel tools has also increased tool life, as has chromium plating of certain types of tools.

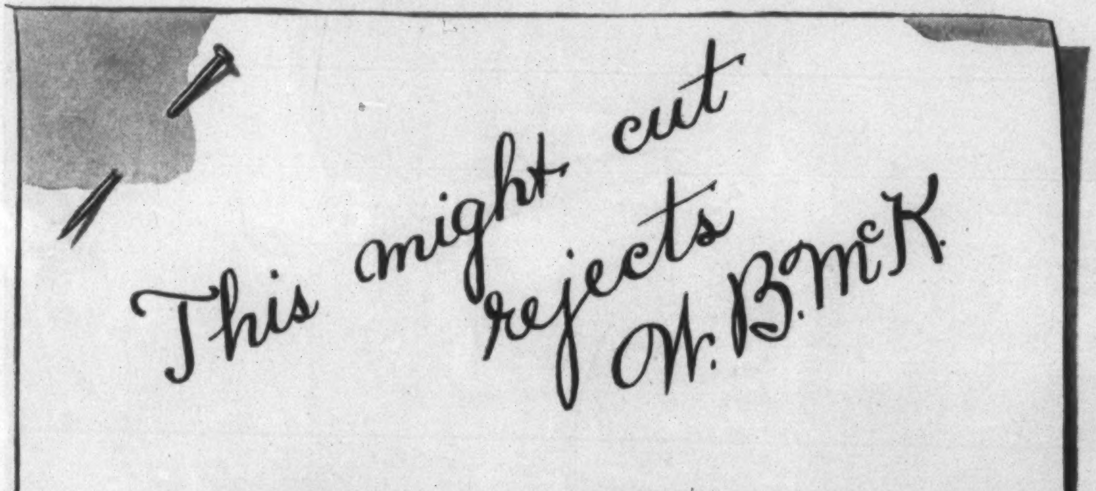
Cutting Fluids and Cutting Speeds

Cutting fluids are more effective for producing good surface quality at low speeds than at high. The cutting speed greatly influences the quality of the machined surface.

At low speeds the finish is often poor, and a high rake, light feed and a cutting fluid consisting of an oil-containing sulphur or chlorine should be used. For each structure a cutting speed is obtained at which a keen cut and burnished surface result.

This speed is lowest for the hardest metals and highest for the softest. At this high speed (*e.g.* cutting steel with carbides), the cutting fluid plays little part in influencing surface quality. Even under normal cutting the chief function of the fluid is believed to be keeping the tool and work cool and prolonging the life of the former.

—O. W. Boston, *Screw Machine Engineering*, Vol. 4, June 1943, pp. 30-34, 36, 38, 40.



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HOW TO SELECT THE RIGHT CUTTING FLUID

1. **For Machining Nickel Steel,** and ductile steels generally, if the cutting operation produces a curling chip that bears heavily on the face of the cutting tool, use a cutting fluid high in anti-weld and anti-friction properties. Such properties are generally found in sulpho-chlorinated oils containing some saponifiable material. If visibility and ease of inspection are also of importance the oil should be of the transparent type. Chillo oils No. 140 or No. 143 will be found particularly adapted for service of this kind.

2. **For Similar Operations** but where transparency is not a factor and where the work warrants the use of a lower priced product of the sulpho-chlorinated type, without saponifiable material, we recommend Cities Service Grade A Cutting Oil. This oil has many satisfied users.

3. **For Less Severe Operations** these base oils can be had in milder concentrations to meet varying requirements—of tool life, finish, cost, etc.

4. **If Maximum Protection Against Staining** is a factor, or if a high degree of transparency is desired, in moderately severe operations, a mineral-lard oil in varying proportions, like Chillo Oils 1 to 5, will be found particularly applicable for the purpose.

5. **Where Cooling Is Of Paramount Importance**—as in grinding operations—to assure accuracy and prevent distortion—oil-water emulsions frequently are desired. This type of cutting fluid is also often selected for operations where cost is a deciding factor. We suggest Cities Service Soluble Oil for these requirements.

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Cuprous Oxide Rectifiers

Condensed from an Electrochemical Society Paper

During the last fifteen years the electroplating industry has changed to one of tanks holding several thousand gallons and current densities of several hundred amperes per sq. ft. or more. This has come about through the development of chromium plating, the low pH nickel bath, anodizing processes, electrolytic descaling and polishing and the use of large automatic equipment. These in turn, together with the high standards of war work have made automatic control essential.

Rectifier Combinations

By the use of cuprous oxide rectifiers high voltage a.c. current may be changed to low votage d. c. for plating, anodizing and similar processes. In addition to large units of 500, 1000 and 2000 amp. ratings, there are package units in 300 and 500 amp. sizes. As illustration of the possibilities of automatic control, take four of the 500 amp. 6-volt units which can be connected in the following ways:

1. All in parallel, giving 2000 amp., 6-volts.
2. Divided into two sets, each set being connected in series, and the two sets connected in parallel giving 1000 amp., 12-volts.
3. All placed in series to give 500 amp., 24-volts.
4. Three units in series to give 500 amp., 18-volts with a 500 amp., 6-volt unit idle.
5. Each unit used singly, giving four 500-amp., 6-volts units.

The larger the rectifier unit required the greater the number of individual units used and of the combinations that may be had. The most common control is that of a definite time cycle to obtain a predetermined thickness of plate at a prescribed current density. Each rectifier has a small magnetic starter with 110-volt, single-phase coil built into it. A delayed relay, or timer, placed on this coil, shuts off the current at the end of a given time.

Nickel and Chromium Plating

In plating barrel operations, if the current demand for a cylinder is 400 to 500 amp., an individual rectifier can be connected direct to each cylinder. A limit switch starts the plating. Removing the cylinder at a warning automatically resets the relay. In plating at 12-volts, with two rectifiers in series, the second delay relay could be connected after the first. The work would be plated at a lower current density for a short period, until the second rectifier coming on raises it. At the end of the cycle, both units would shut off automatically.

In hard chromium plating where some treatments call for the use of reverse current first and then direct, a reversing switch, controlled by a relay, may be installed on the d. c. line. When the cycle has started, the work will receive a reverse current for a definite time, then a direct current at a given amperage so that at the end of the cycle it has received a predetermined thickness of plate.

In full automatic equipment the time is controlled by the speed of travel through the tank. To step up the current density in order to obtain a better plate the rectifiers could be divided into groups running at different voltages. These groups distributed along the machine make a saving of bus bar over that required if the current came from one central point.

Anodizing

Anodizing requires the greatest amount of automatic control. Government specifications often call for a definite step-up of voltage and length of cycle. In chromic acid anodizing, for a 500-amp.-42-volt unit, seven rectifiers would be connected in series, the first having a standard voltage regulator and the others, delayed relays. This would give seven steps of 6 volts each for control. Each unit can be fused for protection against overload. When the final voltage is reached, it would hold until the end of the cycle when all the units would be automatically cut off and the operator warned. Indicating lights show which rectifier is on and what the voltage is.

If the first step required more than 6-volts, the first two units could be turned on and the voltage cut by regulators. If 8-volts were used to start, the final voltage would be 38. If more were also needed for the final voltage, a fixed resistance could be installed between the regulator and rectifier and later by-passed, by the use of an automatic cut-out.

Uniformity

Over- and under-firing, as used by Dempsey in Car Type Furnaces, eliminates the "cold center" so inherent in the plain direct-fired furnace. In addition, it supplies faster heat, saves time and produces excellent uniformity. Illustrating the range of operations for which they are suitable is a single unit now being used for production at temperatures as low as 500°F., at 1200°F. and also giving good uniformity at 1800°F. (name on request). Write for bulletin showing range of standard sizes.

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FOR THE METAL INDUSTRY

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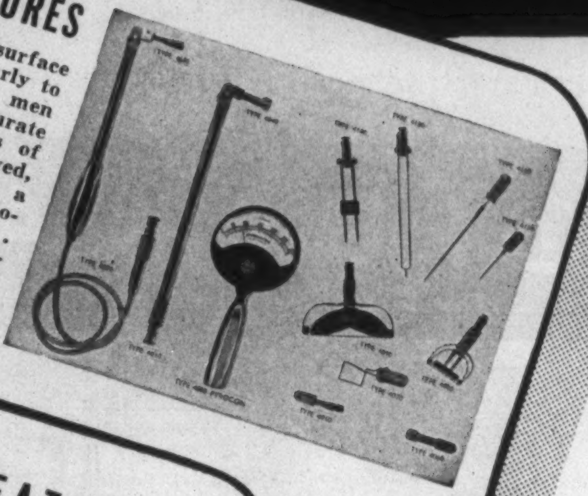

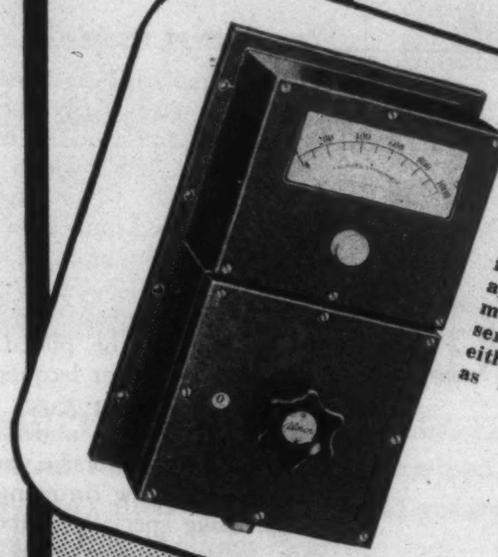

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The "Alnor" rectangular pyrometer has a long scale and is built for high accuracy. This instrument is ideal for use with heat treating furnaces, oven, soft metal pots, and other applications where rugged construction, permanent accuracy, and close readings are essential. This instrument can be supplied for either one circuit or with a selector switch for as many as twenty-eight different positions.

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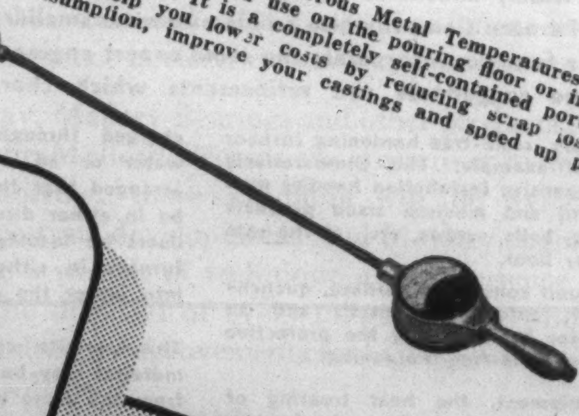
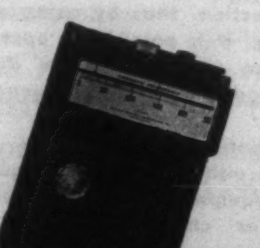
THE ALNOR PYRO-LANCE for Non-Ferrous Metal Temperatures is a rugged, durable pyrometer for hard use on the pouring floor or in the furnace room of the foundry. It is a completely self-contained portable instrument that will help you lower costs by reducing scrap losses, cut your fuel consumption, improve your castings and speed up production.



CONTROL

THE ALNOR ELECTRONIC PYROMETER CONTROLLER provides close temperature control without motors, depressor bars, or other moving mechanical parts. Operating on the electronic principle, the indicating pointer is free at all times to give continuous and accurate temperature readings. This pyrometer controller can be supplied in seven different standard temperature ranges up to 3000° F. Supplied with a hand drawn scale (not printed) for greatest accuracy.



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To prevent an overload on the surge obtained on the first step, a switch could be installed on the first two rectifiers so that on the first step they would come in parallel and then change to series hook-up. Another way would be to use the eighth rectifier unit in parallel with the first step. When the second unit came on, the eighth unit would be automatically cut out. A disconnecting switch on the eighth rectifier would disconnect it from the line.

Sulphuric acid anodizing would use the same arrangement with fewer units of rectifiers due to the lower voltage required.

—G. E. Huenerfauth, *Trans. Electrochemical Soc., Preprint 83-7,* April 1943, 8 pp.

Chromium Plating Dies and Tools

Condensed from "Metal Finishing"

Many kinds of tools and dies are chromium plated in the shop of the Delco-Remy Company at Anderson, Ind. Chromium plating increases the life of drills, taps and reamers used on plastic molded parts four-fold. Spinning tools used for brass do not tear the metal surfaces when chromium-plated.

Plastic molds, after plating with 0.001 inch of chromium, rarely require repolishing, whereas unplated molds required repolishing at intervals varying from hours to a week or two. Chromium plated drawing dies do not score the metal, thus reducing finishing costs and prolonging the life of the dies. Chromium plating of hydraulic rams on molding presses greatly reduces the rate of wear of the leather packing.

Salvaging of over-machined parts, tools, and dies can be done at a cost of not over 10 per cent of the cost of the part and is another of the important applications. It is estimated that salvage operations alone save this company many thousands of dollars a year.

The solution used contains 40-45 oz./gal. of chromic acid and 0.55 to 0.65 oz./gal. of sulfuric acid. The operating temperature is 135-140 deg. F. and the current density is from 100 to 4000 amp./sq. ft., depending on the type of work.

Conventional tank and current supply equipment is used. The generator should have a voltage rating of at least 15 volts.

Preparation of the Work

The preplating treatment usually followed for steel parts consists of solvent degreasing and anodic treatment in the plating bath, after which plating is started immediately. The anodic etching treatment is carried out at a current density of 200 to 300 amp./sq. ft. for a time varying from 15 sec. to 1 min., depending on the kind of steel.

Areas not to be plated are stopped-off with rubber tape or lacquer, or both. Worn parts such as plug gages are first ground 0.003 to 0.004 inch undersize, plated 0.002 to 0.003 inch oversize, and then ground to size. The low throwing power of chromium make specially shaped anodes necessary for plating recessed areas or holes. Latticed anodes built up to shape from lead or solder wires are preferred rather than solid anodes made from lead sheet.

Drills and reamers for plastic are usually ground 0.002 to 0.003 inch undersize, plated about 0.003 inch oversize, and ground to size. Drills and other cutting tools for hard metals are plated with thin deposits of 0.0001 to 0.0003 inch, since thicker deposits will chip in this application. Files are given a thin deposit of 0.0001 to 0.0002 inch. They are plated a short time at a very high current density, *e.g.* a few seconds at 1000 to 4000 amps./sq. ft. Plating cycle details are described for other typical gages and cutting tools.

Finishing

Heat treatment of parts has never been found necessary.

The grinding of chromium presents some problems different from those encountered in grinding steel. The hard chromium is more easily ground with a softer, more free-cutting wheel than might be used for grinding hardened tool steel.

For chromium, an aluminum oxide wheel with about 60 grain abrasive and with a fairly open bond is used. A wheel made with a refined grade of oxide, which has some of the impurities, such as iron oxide removed, does not heat up as much as a wheel made from unrefined oxides.

—D. A. Cotton, *Metal Finishing,* Vol. 41, 1943, pp. 343-347.

EF FURNACES
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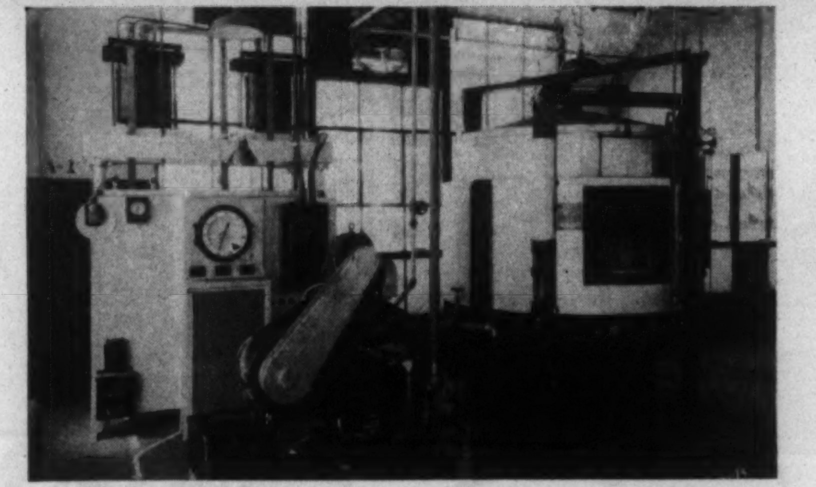

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The above rotary, scale-free hardening furnace is an excellent example. This comparatively small and inexpensive installation handles miscellaneous small and medium sized products such as springs, bolts, screws, etc., at the rate of 250 lbs. per hour.

The complete unit consists of furnace, quenching equipment, automatic controls and an Elfurno generator for supplying the protective atmosphere for scale-free hardening.

With this equipment, the heat treating of miscellaneous small and medium sized parts and products is placed on a practical, continuous, uniform and economical basis. The furnace has two doors and two quench tanks. The material is loaded into heat resisting alloy trays, carried around the furnace and discharged through sealed chutes to either a water or an oil quench. The drive is so arranged that the rotation of the hearth may be in either direction, thus by using opposite doors for loading, it is possible to operate the furnace in either direction and to discharge into either the oil or the water quench.

This permits considerable flexibility as the material may be either oil or water quenched from the same equipment without moving the quench tanks or changing the quenching medium. By removing the material from the trays instead of discharging into quench tanks, this furnace can also be used for drawing, annealing or other processes.

For heat treating from 300 to 1700 lbs. per hour, we recommend the EF Continuous Chain Belt Conveyor Type Furnaces which we build in five standard sizes. These furnaces handle all kinds of products ranging in size from small springs and machine gun cartridge clips up to large track links for tanks and tractors.

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The Mallosil Process makes possible precision production, not only of bearings, bushings, pinion races, gear supports and other aircraft engine parts, but other applications in aircraft manufacture. Collector rings with Mallosil surfacing provide long, efficient service in the control mechanisms of bomber power turrets. Mallosil-processed copper coils, rivets, fuse clips, circuit breakers and relay parts give longer and better performance in electrical and communications devices.

Today, Mallory Bearings and other products improved by the Mallosil Process are given over to War effort. Tomorrow, those products will be available for peace-time development. And Mallory engineers will have a wealth of technique and experience to place at the disposal of every manufacturer who is planning design improvements for high-speed motive units. Consult us.

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4

Materials and Engineering Design

Engineering Properties of Metals and Alloys • Resistance to Corrosion, Wear, Fatigue, Creep, etc. • Engineering Design Problems of Specific Industries and Products • Selection of Metals, Metal-Forms and Fabricating Methods • Non-Metallics in the Metal Industries • Applications of Individual Materials • Conservation and Substitution

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Lead-Coated Steel

Condensed from a Paper for the American Society for Testing Materials

Complete outdoor tests of lead coatings on steel were made by Clarke in the industrial atmosphere of Woolwich, Eng. The lead was deposited in a perchlorate bath on panels of sheet steel.

While porosity existed in the 0.001 in. thick coating, the pores closed up or became filled and ineffective on continued exposure. At the end of three years the coating had become blackened and a slight degree of roughness had developed due to microscopic nodules of corrosion product. No rust was apparent, except at a scratch originally made through the coating; the rust was hard, dark and localized. Such apparent disappearance of pores did not take place in the thinner coatings.

The author has a number of lead-plated panels exposed at 45 deg. on a roof 200 to 300 ft. from a railroad in Detroit, Mich. Plating was done in a lead fluoborate bath with glue as addition agent. Some rust appeared on panels with 0.00025 in. lead after 3 months and after 6 months an average of 6 per cent of the top surfaces and 45 per cent of the bottom were rusted.

After 10½ months the percentage rust was 7 and 73, respectively. Both top and bottom of the panels with 0.0005 and 0.001 in. lead were substantially free from rust after 10½ months. On a nearby roof a 0.0002 in. zinc coating prevented rust for about 7 to 8 months.

Two processes occur on the surface of weather-exposed lead-plated steel: the corrosion of the lead coating and of the steel through the pores in the coating. As the coating is weathered away more pores are opened up in the steel.

Tests of Solid Lead

One may expect that the rate of weathering of the electroplated lead would be of the same order of magnitude as that of solid lead. The Society's Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys exposed vertically 9 by 12 by 0.035 in. weighted panels in a number of test locations. After nearly ten years the corrosion products were removed and the panels reweighed. The weight loss per unit area, all surfaces included, has been recalculated into average decrease in thickness as follows:

Test site type of atmosphere	Years exposed	Thickness corroded, in. × 10^{-6}
LaJolla Cal. (foggy sea coast)	9.14	162
Key West, Fla. (sea coast)	8.78	217
Altoona, Pa. (industrial)	9.25	267
New York, N. Y. (industrial near sea coast)	9.38	167
State College, Pa. (rural)	9.27	189
Phoenix, Ariz. (desert)	3.85	95

Compared with zinc, the performance of the lead was notable except in Key West and Phoenix, both of which attack zinc very slowly. Where corrosion was at all severe, the attack on lead was definitely less than on copper. Lead corroded more slowly than nickel only in atmospheres high in sulfur trioxide.

In England, tests made by Hudson with 2½ by 2 by 0.04 in. panels for 1 year only and by Friend with weighted rods exposed for 7 years (near Hudson's Birmingham station), show the following results:

Test site type of atmosphere	Years exposed	Thickness corroded, in. × 10^{-6}
Cardington (rural)	1	56
Bournville (suburban)	1	77
Birmingham (urban)	1	145
Birmingham (urban)	7	238
Wakefield (industrial)	1	74
Southport (marine)	1	70

Comparison of the 1 and 7 years exposure in Birmingham seems to show that the lead sulfate etc. film formed has considerable protective value in this atmosphere. Data on the dust settling in the different locations shows all the English sites heavily contaminated. The amount of sulfur trioxide shows that probably the corrosion products were always sulfates.

Galvanic Couple Tests

Committee B-3 also made galvanic couple tests of the effect of porosity of lead coatings. Washers of different metals were bolted together so that the only metallic contact was between the washers being tested and the only surfaces subjected to the atmosphere were those of the edges. As the couples deteriorated during the tests the exposed areas did not remain constant and it is difficult to draw definite conclusions.

However, it appears that lead coatings protect the iron electrochemically better in uncontaminated or seacoast atmospheres than in industrial. Chlorides in industrial atmospheres seem to increase the protective ability of the lead. In a strictly industrial atmosphere lead may actually accelerate corrosion of the steel. It was also shown that while lead is more anodic than copper or nickel it is not comparable with

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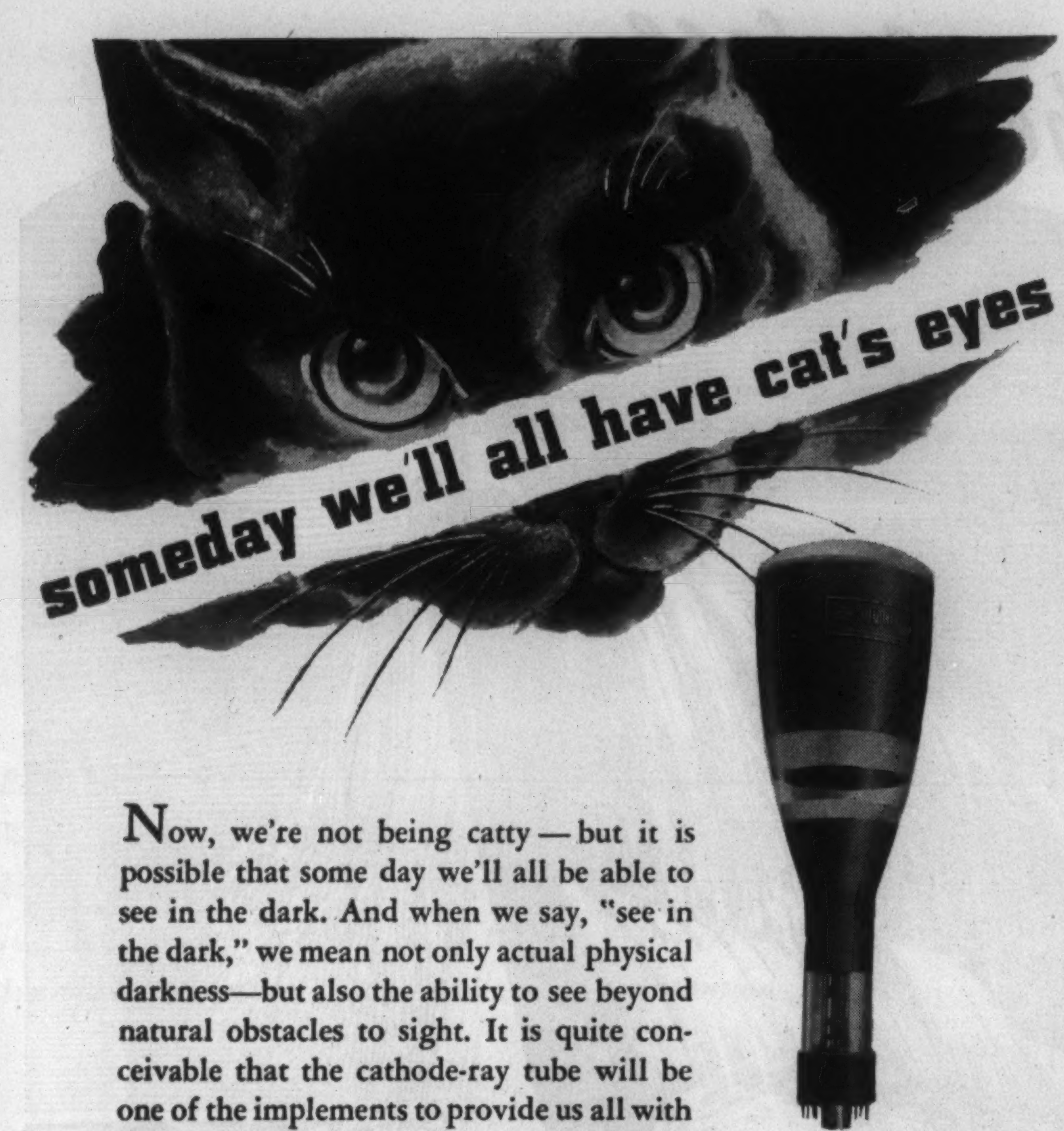
someday we'll all have cat's eyes

Now, we're not being catty — but it is possible that some day we'll all be able to see in the dark. And when we say, "see in the dark," we mean not only actual physical darkness—but also the ability to see beyond natural obstacles to sight. It is quite conceivable that the cathode-ray tube will be one of the implements to provide us all with cat's eyes. A short decade ago, this now commonplace industrial tool was a rarity—a laboratory curiosity. Pioneered by the Allen B. DuMont Laboratories, the commercial cathode-ray tube of today is speeding production, reducing waste and helping make an all-around better product.

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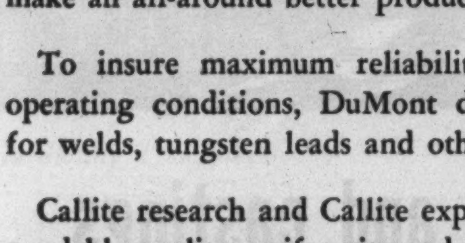

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zinc. The porosity of the coating depends on the base metal and the structure of the lead deposit. Light burnishing and even scratch brushing assist in making thin lead coatings less porous.

Indoor Exposure

Indoor exposure of lead plated steel panels for six winter months in an unheated house in Woolwich, Eng. showed numerous rust spots with a 0.00005 in. coating, a few with a 0.0005 in. coating and none with a coating of 0.002 in.

Solid rods, held horizontally in wooden frames were immersed for 4 years in the Bristol Channel and for 3 years in the quiet, muddy and oily waters of the Southampton Docks, Eng. One inch on each end of the specimen was set in an "insulating" material. Results indicated that lead coating of the thicknesses covered by the new lead-plating specifications probably would not protect steel long when immersed even in quiet sea water.

Tests made on lead in contact with other metals show that under no circumstances should lead-plated steel come in contact with aluminum. Generally it should be kept away from zinc. Ordinarily it would not cause acceleration of the corrosion of copper, iron, nickel or tin. In seacoast atmospheres and in relatively noncorrosive rural and desert atmospheres these metals are protected. In industrial atmospheres the lead may act either way, but in no case is the acceleration of corrosion of either the lead or the other metals pronounced.

Physical Properties

The physical properties of lead coatings affect their usefulness in any particular application. The melting point of lead is very low, the boiling point high. Fumes of lead oxide are formed at bright red heat. High-temperature applications should be avoided as lead salts are very poisonous.

While a lead-coated steel sheet can be easily spot welded to plain steel, it cannot be to another lead-coated sheet. It can be soldered but with some difficulty.

The electrical conductivity of lead is about 8.2 per cent of that of silver. It is used in connection with storage batteries. The corrosion products are poor conductors but are easily penetrated because of the softness of the lead underneath.

Next to thallium, lead is the softest of all the heavy metals. Brinell hardness as low as 3 kg. per mm. has been found at room temperature. Plated coatings are harder. It hardens on cold working but self-anneals at room temperature. Lead plated parts that are to be handled roughly should have an extra thickness. This softness is an advantage in the case of lead plated gaskets and packing rings. When hit with blunt objects the lead flows but does not crack.

The tensile strength of lead is low — 1800 to 3000 psi. — depending on the amount of cold work and the rate of testing. However, lead plated sheets are easily bent without cracking. Lead makes a suitable coating on springs as it does not cause embrittlement of the base metal.

The specific gravity of lead is about 11.35. One cubic ft. weighs about 706

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lb. A 0.0001 in. thick coating weighs 0.094 oz. per sq. ft.

Uses for Electrodeposited Lead Coatings

Before the war lead plating on steel in this country was limited to a few uses such as storage battery fittings, boosters, adapters and linings of gas shells. Gas heater flues, brine tanks and linings for chemical apparatus were proposed. Thicknesses of 0.003 to 0.005 in. are suggested as substantially nonporous. Lead plated nuts and bolts usually have a thickness of 0.0005 to 0.001 in. and most ferrous metals 0.0005 to 0.008 in.

These coatings have been more generally used in Europe for coil springs, gas mask parts, steam water heaters and packing rings. Steel sheet lead-plated to 0.00052 in. is advocated there for roofing sheet, gasoline tanks and ice containers. Structural members used in building railroad stations, tunnels and bridges and railroad screws, bolts and nails are lead coated in Germany. German railroads specify a 0.012 in. coating on structural parts providing an expected life of 10 to 20 years. Nuts and bolts usually have a thickness of 0.005 to 0.001 in.

—Gustaf Soderberg, *American Society for Testing Materials, Preprint No. 30,* June 1943 meeting.

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Creep Strength of Titanium Steels

Condensed from "Archiv Eisenhüttenwesen"

When adding titanium to steels with 0.05-0.2 per cent C a maximum of creep strength was found, after quenching from 2200 deg. F. in water and drawing to 1110 deg. F., at 930 deg. F., for all carbon contents at a ratio of titanium:carbon = 6 to 9. The magnitude of this maximum depends on the carbon content, the best values are obtained at carbon contents of more than 0.08 per cent.

Addition of chromium to titanium steels enlarges the range of highest creep strength given by the ratio of titanium to carbon. Silicon steels have a comparatively high creep strength (about 25,000 lbs. per sq. in.) only if the carbon content is kept as low as possible. By binding carbon to a special carbide forming element, *e.g.* titanium, silicon steels with high creep strength (more than 55,000 lbs. per sq. in.) can be produced.

Additions of molybdenum, vanadium, and tungsten increase the creep strength of titanium steels. The best obtainable values in this way exceed those maximum values which can be reached with each alloying element alone. The titanium steels used in these experiments contained up to 2 per cent Ti; the tests extended up to 1250 hr.

—P. Bardenheuer & W. A. Fischer, *Arch. Eisenhüttenw.*, Vol. 16, July 1942, pp. 31-38.

Die Forged Machine Parts

Condensed from "Product Engineering"

Die forgings are broadly classified into 4 sub-divisions: (1) Hammer die-forgings [or more familiarly, "drop forgings"] (2) press die-forgings, (3) upset forgings (those produced in swaging machines, bulldozers, forging rolls and cold-forging machines).

The most important advantage of die forgings is their high strength, for withstanding impact stresses greater than the tensile and compressive loads for which a part is designed. Thus the size and weight of a part may be reduced.

Saving in material is further augmented by the ability to hold dimensional tolerances closer than in a sand casting. Dimensional precision is of the same degree as permanent mold casting. Die-forging flash, too, involves less waste than casting sprues.

In deciding whether die-forgings should be specified, it should be remembered that the process is best for mass production, because of high die costs. As to material, plain carbon and low-alloy steels with 0.1 to 0.5 per cent C, copper and copper-base alloys, and aluminum alloys are the materials most commonly die-forged.

Types of Die Forgings Compared

Hammer die-forgings or drop forgings are formed by the impact of dies on the metal being worked. Parts requiring considerable drawings are made on steam-drop-hammers; those of small size or flat, thin shapes on a board-drop machine. With hammer forging multiple impressions in a die block can be made, and bar stock can

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be worked into the finished forging without preheating.

Press die-forgings, formed by the pressure of dies in hydraulic or mechanical presses, are completed in one or more operations. Upset forgings are formed when bar stock is gripped between two dies. struck by a heading tool and shortened axially.

Swaging machines produce work rapidly and within close dimensions, and are especially useful for parts of small diameter. Forging rolls have many applications in which a reduced straight or taper section is produced. Cold-forging or cold heading is similar to upsetting and is an increasingly used alternative to screw-machine work.

Small die forgings weighing a fraction of an ounce can be made as press die-forgings. Small upsetting machines and swaging machines excel for small parts. Presses can be used to make die-forgings up to 25 lbs.

Design Rules

Sufficient draft should be allowed to facilitate removal of the forging from the die, but not so great as to increase machining costs unduly. Forgings should be so designed that approximately equal volumes of metal are at each side of the parting line, and so that the die can be parted in one plane.

All sharp inside corners and sharp exterior edges and corners should be avoided. Fillets commonly run from 3/64 in. minimum for small forgings to 1/8 in. minimum for 100-lb. forgings. Abrupt changes in section thickness should be avoided. Sections should not be designed too thin to be readily forged.

Location points for machining must not be close to die partings. Sufficient material should be allowed for machining at all points where finishing is necessary. Die-forgings can be coined cold to approximate the finish obtained by machining and to achieve dimensional precision. Where large holes are to be drilled in forgings parallel to the die motion, the holes should be spotted by the forging dies.

Material used for forging should have a fine-grained structure. The finished forgings should be free of scale. If to be used in vibration service the scale removal should be by shot blasting rather than pickling.

Deep pockets should be avoided and recesses made as simple in shape as possible.

—C. L. Tutt, Jr., *Product Engineering*, Vol. 14, Aug. 1943, pp. 521-525.

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Substitute Solder for Cans

Condensed from a War Metallurgy Committee Report

In the four years 1935-1938, solder took 22 to 25 per cent of the long tons of tin used in the United States. The major uses were in dip-soldering automobile radiators and in soldering cans. Food cans, as a whole, required about 10 per cent as much tin for the solder as for the hot-dipped tin plate then used.

On cans for evaporated milk the proportion is greater. For ordinary food the "sanitary can" has solder only in the side seam but those for evaporated milk known as "floated-end" have both ends soldered on also.

Before Pearl Harbor, the can-makers had satisfied themselves that a solder of 97.5 lead, 2.5 silver could be used on the automatic can making lines. Radiator-dipping, it was found, could also be done with such a solder, the silver content usually being raised to 4 or 5 per cent.

A solder of this type, usually containing about 0.25 per cent copper as well as 2½ per cent silver, has long been used by the Westinghouse Electric & Manufacturing Co. It was known that properly made joints were stronger soldered with this than with tin-lead. Therefore, in cases where only the adaptation of shop technique and the demonstration of mechanical strength were involved, there were no major barriers to the substitution.

Health Hazards

In the case of food cans, adequate proof that the solder did not introduce health hazards was required. The questions were: (a) Does the solder dissolve in the food so as to create hazard of lead poisoning? and (b) Do drops spattered accidentally into the can have poisonous effects when swallowed?

The National Canners Assn. carried out an extensive program of examination of the first question. Several makers carried out independent programs, and Dr. Cow-

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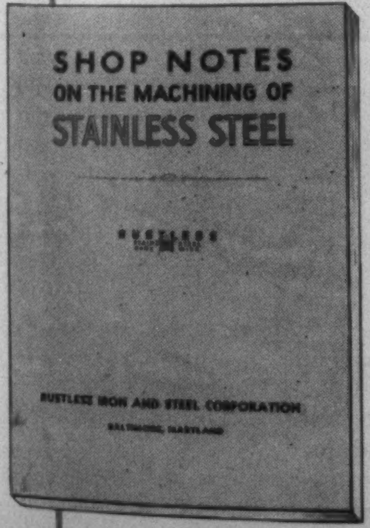

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gill, at Yale, investigated the question of spatter pellets in a program financed by W.P.B. Particular emphasis was put on evaporated milk because of the large use of solder in that case and its importance in infant feeding.

Cadmium or bismuth solders, which can be made with the tin content much below that of ordinary solder, were suggested. Cadmium was barred for food as it is toxic and moreover the supply would not be adequate. Experiments with bismuth proved that unless the seams were held under pressure while the solder froze, the joint would split. As there is ample silver for industrial use and its toxicity can be ignored, the problem resolved itself into that of lead alone.

The upper limit of permissible dissolved lead in canned foods is 2 parts per million. Evaporated milk, orange juice, chopped green beans and corned beef hamburger were selected by the National Canners Assn. for study. These foods were processed as usual, in glass jars containing a disc of commercial tin plate with the edges coated with three silver-lead solders. They were stored for 9 months at 98 deg. F.—equivalent to 2 years' ordinary storage. Data were obtained at 3 month intervals. None of the foods showed progressive pick-up.

Reaction with Specific Foods

After storage, samples from the cans were analyzed and the amount of lead in parts per million calculated back to the pick-up of lead in sanitary and floated-end cans. The average of the three substitutes showed the average part per million lead to be: Corned beef—0.09; green beans—0.03; orange juice—0.08; evaporated milk—0.34.

The Continental Can Co., in a similar experiment for 8 months, reported the following results: green beans—0.03; corned beef—0.10; peas—0.03; grapefruit juice (12 months)—0.07. Grapefruit juice was also packed in actual No. 2 cans soldered with 70 lead 30 tin, 95 lead 2½ silver 2½ tin, and with pure lead. After four months at room temperature the average of each was 0.07 part per million. Similar tests on tomato juice gave an average of 0.13-0.14.

The Pet Milk Co. found 0.16 part per million in evaporated milk stored 2 months in cans soldered with 97½ lead 2½ silver solder. The Continental Can Co. found that evaporated milk stored 4 months at room temperature in contact with solder discs, showed less lead than the original milk. After 8 months it showed from none to 0.02. This is due to some protein compound of lead that precipitates tightly on the can walls.

Dr. Cowgill's report on solder pellets which might be spattered into the food proves that they cannot be regarded as presenting a serious lead hazard. Rats, fed for 4 months on a diet containing 300 parts per million of lead as solder pellets, showed no signs of lead intoxication.

In addition to being safe for food cans, as proved by this evidence, it is noted that the lead-silver solder, either at present pegged prices or at normal ones, is no more expensive in raw material cost than the 60 lead 40 tin solder.

—H. W. Gillett, Information Release No. 6,
War Metallurgy Committee, August,
1943, 8 mimeographed pages.

Oil Viscosity and Cylinder Wear

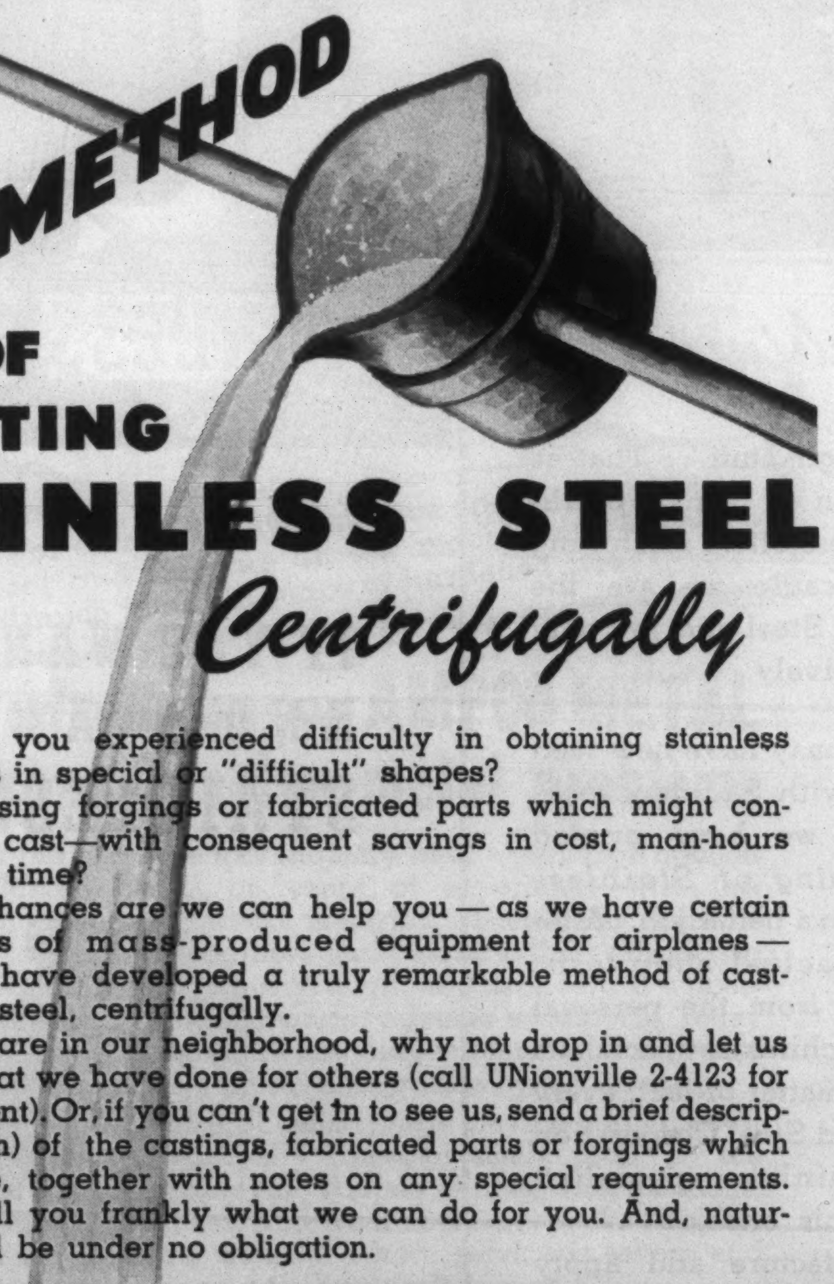
Condensed from "S.A.E. Journal"

Tests were undertaken to determine the influence on wear of piston rings and cylinder walls of automobile engines of only the viscosity of lubricating oil. Special precautions were taken to eliminate all other variables.

Tests were made with 6 oils ranging from a viscosity lighter than S.A.E. 10 to greater than S.A.E. 70. All the oils run were blends of conventionally refined bright stock and neutral from a Pennsylvania crude oil.

Each oil was tested in a battery of 6 single-cylinder engines operating under conditions artificially controlled to simulate closely moderately heavy-duty road operation of automobile passenger-car engines. Runs were of 8-hr. duration. Before the start of each test the engines were completely overhauled.

The amount of iron wear in the cylinders was measured by evaluating the iron contamination of the crankcase oil, adjusted to allow for the oil that had been lost by consumption, leakage, and sampling.



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METALS AND ALLOYS EDITION **No. 12**

DIE CAST SHANKS FOR UNIFORM BUTTONS

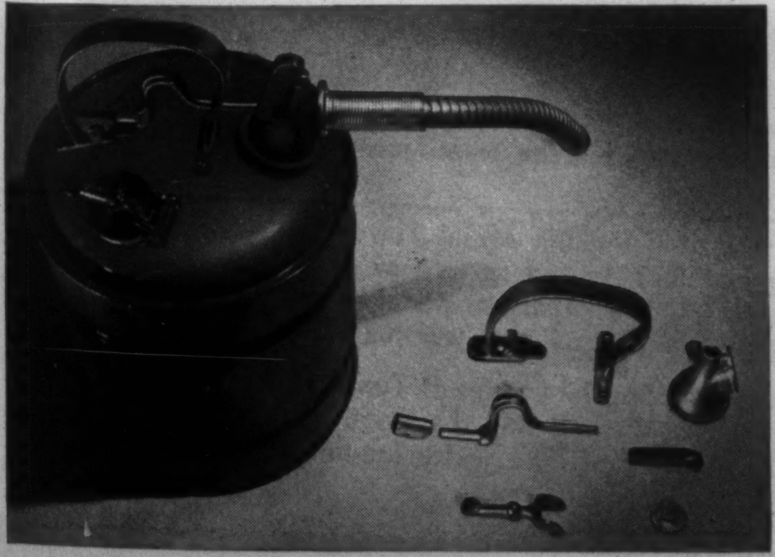
Note the shanks on the buttons in the foreground

The War Department has announced that all of the brass buttons on the overcoats and blouses of enlisted men in the United States Army will be replaced as quickly as possible by plastic buttons with zinc alloy die cast shanks (the illustration above shows Navy and Merchant Marine buttons so made, also). The change will result in a saving of 365,000 pounds of metal this year by the Army alone.

This saving will make everyone very happy—except, possibly, the soldiers themselves. We are told that they will have to sew their own buttons on, or get a girl friend to do the job for them. After the change is made, however, the men in khaki will find that the new buttons are on to stay—thanks to the strength of zinc alloy die cast shanks imbedded deeply in the plastic.

7 DIE CASTINGS IN A SAFETY CAN ASSEMBLY

The safety can, below, is a boon to the wartime conservation program. It is designed to facilitate the storing and dispensing of volatile and inflammable liquids. The leakproof spout and fill-opening prevent loss by evaporation, and special perforated fire baffles in both openings prevent ignition of the can's contents.



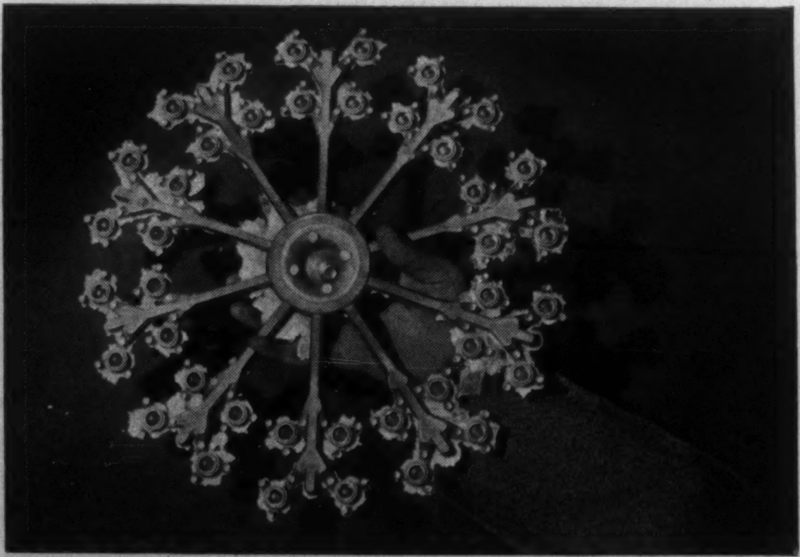
This can can be filled or emptied in one minute

The illustration reveals that the carrying handle, the spout assembly and the fill-opening hinge handle are all zinc alloy die castings. Because of the unusual shapes obtainable through the die casting process, the number of parts is reduced to an absolute minimum. Smooth, easily finished as-cast surfaces are an inherent quality of the castings, as is the necessary strength to withstand hard use.

40 SHELL FUZE BODIES CAST AT ONE TIME

40 Navy 20 MM. shell fuze bodies are cast at one time on the "gate" shown here—at the rate of 3 "gates" a minute. This speed of production, plus excellent physical and mechanical properties, makes zinc alloy die castings adaptable for critical ordnance components.

Does this, and the other applications on this page, give you a suggestion for improving your present war production? Does it offer possibilities for consideration in your post-war planning program? We will be glad to send you complete descriptive literature on zinc alloy die castings.



The individual fuze bodies are easily removed

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The results of the tests indicate that cylinder and ring wear in well lubricated engines decreases progressively with increasing viscosity throughout the range tested. The wear is almost inversely proportional to the kinematic viscosity. Fluid-film action appeared to be predominant through the major part of the reciprocating cycle.

—H. A. Everett, *S.A.E. Journal*, Vol. 51, May 1943, Trans. pp. 165-169.

Hardening Tool Steels

Condensed from "Canadian Metals & Met. Industries"

Contrary to a somewhat general impression, quality in itself is not being sacrificed by tool steel manufacturers. Even though it has been necessary to take vanadium out of all tool steels except high speed, they have not suffered in quality because other alternates are available. However there are certain factors which have a direct bearing on the performance of tool steels over which users have control.

Resourceful manufacturers have found that for wearing surfaces of cutting tools, dies, gauges, etc., the finer the finish, the better the performance. This finish is often further improved by chromium plating or nitriding. For beneficial results from this, the finish or the cutting surfaces of the tools must be especially smooth. Also hydrogen embrittlement resulting from absorption of hydrogen from the acid bath should be minimized by tempering at 300-400 deg. F. after plating. In nitriding, immersion in a salt bath should not be too short. At least an hour is usually necessary.

Heat Treatment

In addition to good equipment, the tool hardener must know certain fundamentals. In estimating the hardening temperature the average of the largest and smallest sections of the work must be determined. The hardening temperature range is from 50 to 100 deg. F. and in general the lower third of the range should be used for average sections up to 1 in., the middle third for those between 1 and 2 in. and the top for those over 2 in.

Regularly shaped medium or large tools or intricate tools of any size should not be heated rapidly through the critical range or distortion may occur before quenching. The best guarantee against this is preheating thoroughly just below the critical range. Tools in the furnace chamber should be placed or supported so that sagging under their own weight cannot occur. There should be circulation of hot air around and under the tools.

With the possible exception of high speed steel, the mass of a tool should be uniformly heated throughout before quenching and soaked just long enough to get proper solution of the carbides. A conservative rule would be about 20 min. per in. of the maximum dimensions of the tool. Soaking at hardening heat has generally been over done. It causes excessive decarburization and scaling, grain-coarsening and brittleness, decreased wear-resistance and even quenching cracks.

Trying to quench the work just long enough is a critical procedure. Generally it is safer to quench to just above the temperature of the bath, but not over 200 deg. F. Water and brine both should be about 70-90 deg. and oil baths between 100-125 deg. F. High speed steel may be handled as an exception to this. An interrupted quench tends to minimize cracking and permits straightening of warped tools. In intricate tools, the quenching strains are unbalanced and may cause cracks or excessive warping. Various sections of the tools may be balanced by plugging holes or shielding corners. Only holes which unbalance the cross section should be plugged.

The drawing or tempering should follow quenching immediately but not before the tools have approached room temperature or breakage will occur. The longer the time at a given drawing temperature, the more strain-relieved the tool. Compatible with required hardness, it is better to draw a longer time at a lower temperature than a shorter time at a higher one. A minimum basis for drawing time at heat is one hour per in. of thickness for carbon and low alloy tool steels and two hours for high carbon, high chromium, hot-work and high speed steels. With high speed steels, double drawing is best.

—H. B. Chambers, *Canadian Metals & Met. Industries*, Vol. 6, June 1943, pp. 24-26, 33.

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The Riverside Metal Company announced the production of Beryllium Copper in 1933. Immediately the possibilities of Riverside Beryllium Copper as an outstanding spring material aroused the attention of the engineering world. But it took the ability of wrought Beryllium Copper to meet the highly exacting specifications of the Army, Navy and Air Corps to broaden its use. For, as a spring material, Beryllium Copper offers extraordinary advantages because of the invaluable properties it possesses: High fatigue strength, elastic limit and hardness; relatively high tensile strength and electrical conductivity; excellent corrosion and wear resistance; good resistance to room temperature creep and to galling against steel, plus a fabrication advantage which permits good formability of intricate parts and their subsequent hardening—to an unprecedented degree—by a simple heat treatment. Riverside Beryllium Copper is now being used for spring purposes in aircraft, ships, tanks, guns, instruments, engines, motors, radios, telephones, telegraph and electrical control equipment for machinery and fire equipment. Riverside engineering and laboratory service is most important in cooperating with the development of devices where the use of Beryllium Copper springs are indicated, because it represents years of progressive pioneering in solving such problems. Riverside Beryllium Copper meets the requirements of A.S.T.M., B120-41T.

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5

Testing, Inspection and Control

Specifications • Physical and Mechanical Property Testing and Inspection • Routine Control and Instrumentation • Radiography and Magnetic Inspection, Spectrographic and Photoelastic Analysis • Corrosion- and Wear-Testing • Examination of Coatings • Surface Measurements • Metallographic Inspection and Technique

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Radiography of Light Alloys

Condensed from "The Iron Age"

One of the most vital factors in making a radiograph is the subject of contrast. Radiographic contrast and quality rise as the voltage on the X-ray tube goes down.

The most satisfactory X-ray technique for producing a "contrasty" radiograph is that which results in the greatest photographic density change between any two steps. A radiograph which shows up clearly all the extreme thickness variations of an unevenly shaped object looks good to the eye. Such a technique entirely washes out the minor changes in thickness, the smaller defects, the finer porosity, and usually any chemical inequalities.

There are two types of X-rays: the broad general range of wave lengths emitted by any X-ray tube and the narrow characteristic band emitted when voltage on the tube is up to or above the critical valve for that particular target material. Thus, with the copper and molybdenum tubes it is possible to produce the general X-ray with a superimposed bump of characteristic radiation of each. It is this bump which is supposed to bring the extra benefit.

Using an aluminum step tablet, three sets of radiographs were made operating at 12, 24, and 40 kv. At 12 kv. general and characteristic radiations were emitted from copper tube, but from the molybdenum and tungsten targets only general or white radiation could be expected.

At most voltages, the X-ray output intensity of a tungsten target tube far exceeds that of any other material in common use. Since its efficiency is so high, it would seem logical to adhere to the tungsten target while demanding more flexibility as far as emission wave lengths are concerned.

What is most urgently needed is a tungsten target tube with extremely low filtration, yet one which will operate at high enough voltages so that use for general radiography and light alloy inspection will be economically feasible.

—Robert C. Woods & C. V. Cetrone, *Iron Age*, Vol. 151, Mar. 25, 1943, pp. 52-58.

New Smoothness Test

Condensed from "Mitt. Kaiser-Wilhelm Inst. Eisenforsch., Düsseldorf"

A new method is described which permits the determination for both highly polished and very rough surfaces the surface smoothness and curvature. It can be standardized and used in routine measurements in the shop.

It consists in determining the quality as quotient between the light thrown into the microscope objective by the surface under bright-field illumination and the same under dark-field illumination. The reciprocal value is defined as a measure of the roughness. The method lends itself very well for determining the differences of different surface treatments.

—J. Heyes & W. Lueg, *Mitt. Kaiser-Wilhelm Inst. Eisenforsch. Düsseldorf*, Vol. 24, No. 3, 1942, pp. 31-39.

Radiography in the Foundry

Condensed from "Foundry Trade Journal"

Non-destructive testing by radiography shows where the faults, if any, really are—sometimes a quite surprising feature—and at the same time leaves the casting intact.

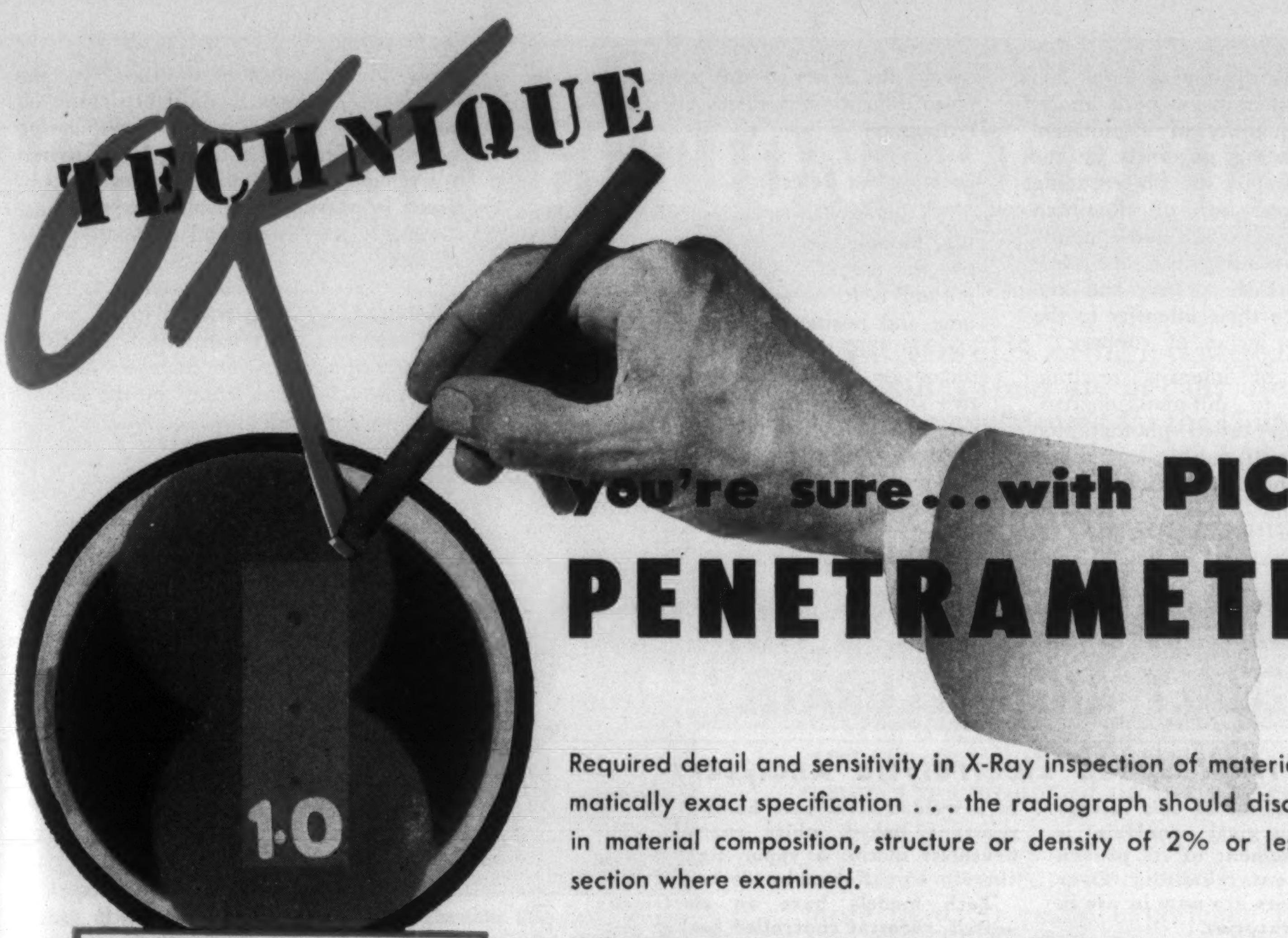
Radiography is not new to the foundry trade, and in fact radiographic examination of metallic articles was accomplished about 1900, and by 1930 it was well established as a method of testing in the light alloy field. Its more universal application was, however, probably hindered by the fact that whereas the short exposure times allowable before overheating, and the comparatively low voltages used in the early X-ray tubes, would quite satisfactorily radiograph light alloys, they were of little use to founders of the denser non-ferrous and ferrous alloys.

Equipment

The latter require X-ray equipment of higher penetration ranging from 100 to 400 kv. according to the thickness they are likely to encounter, or a radium source of gamma rays, corresponding to X-rays emitted by an X-ray plant operating at about 1500 kv. Industrial X-ray equipments capable of giving 1000 kv. are in use in the U.S.A.

The results of X-ray and gamma ray examination are recorded on a photographic film, a radiograph, which provides a permanent record. X-rays can also be viewed on a fluorescent screen, when the record is non-permanent, and the results are noted by the radiographer at the time of the examination. This method however, is only limited to thin sections of the heavier metals.

A radiograph is obtained through the ability of a percentage of the X-rays emitted by an X-ray tube or the gamma rays emitted by a quantity of radium to



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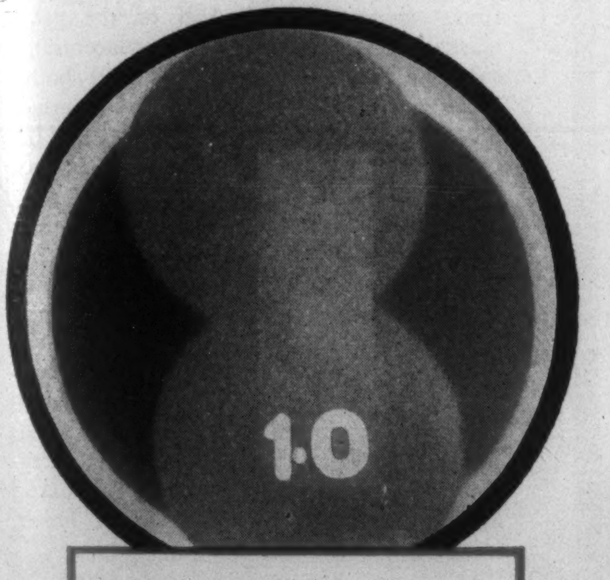
PENETRAMETERS

Good Technique . . . the penetrameter image is clear, the holes distinct . . . a sure indication of correct technique.

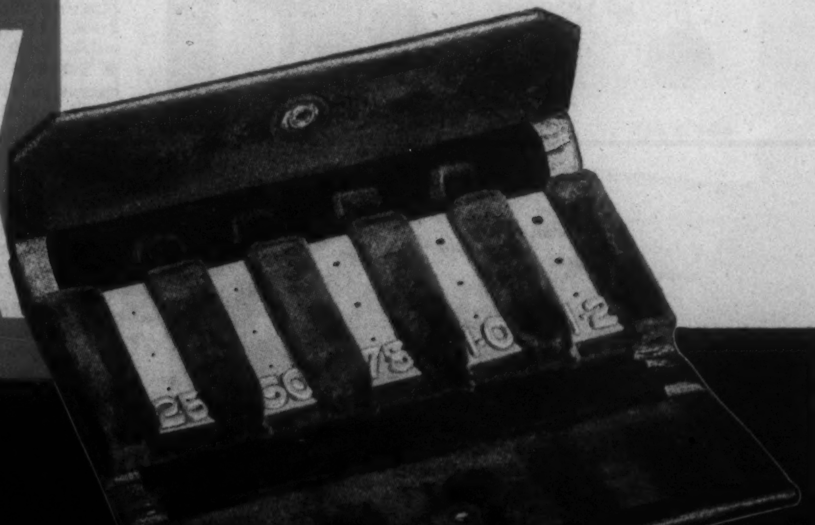
Required detail and sensitivity in X-Ray inspection of materials is a mathematically exact specification . . . the radiograph should disclose a change in material composition, structure or density of 2% or less through the section where examined.

Picker Penetrameters provide an infallible check upon sensitivity . . . a means whereby definition may be exactly measured and technique accurately controlled. Examination of the penetrameter image in the radiograph will disclose shortcomings of technique: if the image is clear and the holes sharp, the technique is correct. If, on the other hand, the holes are indistinct or disappear altogether, the technique must be faulty. The examples shown here are evidence of the simplicity and reliability of the Penetrameter method.

Picker Penetrameters are machined to standards of extreme precision, conforming fully to rigid Army-Navy specifications. Each penetrameter is identified by lead numerals indicating the metal thickness it is designed for. Furnished in various base metals, and either singly or in sets. Further details and prices on application.



Faulty Technique . . . the image has almost disappeared, the holes gone. Proof positive of faulty technique.



PX

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pass through objects opaque to light and then to react on the emulsion of a photographic film, the quantity of a radiation reaching the film being governed by the density and thickness of the object being examined. Thus, one inch of aluminum will not absorb the rays and consequently will not reduce their intensity to the same extent as one inch of copper, and the latter will not reduce their intensity to the same extent as two inches of copper.

These variations of intensity reaching the film affect it to different degrees, resulting in what is called photographic contrast on the film. If the block of metal contains a cavity, another density will be recorded on the film. The smaller the cavity, the lower is this contrast, and the more difficult it is to see its image on the radiograph.

Locating the Defect

To know that a cavity exists in a casting, though useful, is not sufficient to justify the use of radiography. What is important is to be able to determine its volume and position in the casting. To ascertain the volume of the cavity three dimensions must be known. Of these, the two at right angles to the direction of the rays can be determined by direct measurement of the image of the cavity on the radiograph.

In order to determine the extent of the cavity in the direction of the rays, the radiographer aims at a constant density on that part of the radiograph corresponding to the section of the casting it is desired to examine. This standard density is obtained by varying the time of exposure according to the density and thickness of the section.

The extent of the cavity can be determined by comparison with a set of standard films. The location of the cavity in the castings may be found by one of three methods, all described by the author.

—W. Gladwell, *Foundry Trade J.*, Vol. 70, May 6, 1943, pp. 3-8; May 13, pp. 23-25; May 20, pp. 55-57, 54.

Testing Finishes

Condensed from "Metal Finishing"

Testing procedures applied to organic finishes in the laboratories of Servel, Inc., are described. Organic finishes on cold rolled furniture steel must withstand 12 successive immersions in boiling water, and 2000 hrs. immersion in aerated distilled water at 110 deg. F. Coatings are required to withstand an atmosphere with 100 per cent relative humidity at 110 deg. F. for 2000 hrs.

Flexibility and adherence of coatings are judged by a bend test, in which panels are placed on a ¼-in. mandrel and given a 180 deg. bend. An impact test is also used for this purpose.

An effective test of the resistance of coatings to cooking grease has been developed. The test panel is placed in a fume cabinet with one-half of the panel masked. It is exposed to a concentrated fume mixture of cooking oil and butter for 150 hrs. At the end of this exposure there must be no line of demarcation between the exposed and masked portion of the finish.

An effective abrasion test has also been developed. The tester has metal feet covered with felt pads. These pads pass over the test panel with a reciprocating motion.

With the pads saturated with rancid butter, the finish must withstand 150,000 double strokes with the feet unweighted, and the same number with the feet carrying a 5 lb. load. The pads may be soaked in other agents likely to attack a finish, such as stale beer, lemon juice, etc.

Outdoor exposure tests are also made, to check resistance to atmospheric conditions and resistance of colored finishes to fading. An accelerated aging test consists of exposure of the samples in a dry heat cabinet for 84 days. Every 14 days the panels are removed and submitted to the impact test to check for brittleness and loss of adhesion.

Interchangeability of cabinet panels makes color control essential. A half-pint wet sample of the current batch of material is sent to the paint supplier before the batch is all used. Before a new batch shipment, a pre-shipment sample is provided by the supplier and the shipment is not released until careful color matching tests have shown that the color of the new batch is satisfactory.

Other tests regularly carried out include hiding power, per cent reduction, total solids, hardness, curing of film, distensi-

METALLURGICAL PRODUCTS ANALYZED SPEEDILY AND ACCURATELY

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The rapid acceptance of this instrument for metallurgical analysis is outstanding endorsement of its proven ability and consistent reliability. Over 700 Slomin Analyzers are now in use in metallurgical laboratories.

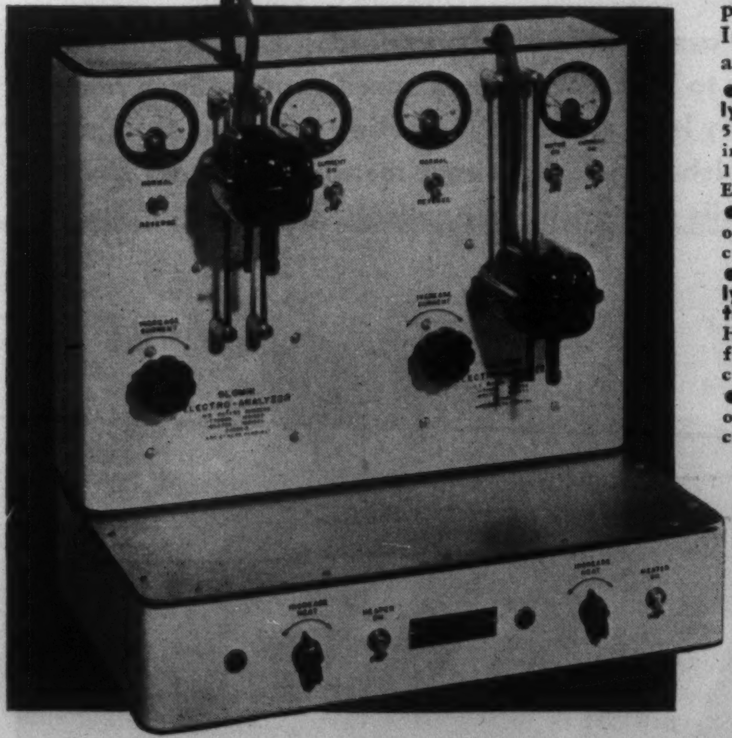
Electrode design, current efficiency and improved procedures reduce deposition time formerly required by other systems as much as 25 to 40%. Under these high speed conditions hard, smooth, bright and closely grained deposits that firmly adhere to the electrodes are produced, thus assuring good reproducibility of results. Users report an accuracy of 0.01 to 0.04% for routine determinations.

Each model is portable and enclosed in a welded steel case finished in acid resistant baked white enamel. The brushless motor is vapor tight and is therefore unaffected by corrosive fumes.

Both models have an electrically heated, rheostat controlled beaker platform for adjusting solution temperatures, and voltmeters and ammeters so that detailed studies can be made.

Each position of the two place analyzer is a complete circuit that operates independently of the other. Consequently this unit can be used for the simultaneous determination of two samples having widely divergent characteristics.

A laboratory manual of high speed electrolytic methods of analysis written by G. W. Slomin is supplied with each analyzer. Individual copies are available at $1.50 each.



- **S-29460 Slomin Electrolytic Analyzer. One position.** 5 Ampere Model, with Heating Plate. For operation from 115 volt, 60 cycle circuits. Each **$155.00**
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- **S-29632 Corrugated Platinum Anode** (Patent pending). Price subject to market.
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Literature on Request

E. H. SARGENT & CO., 155-165 E. Superior St., Chicago, Ill.
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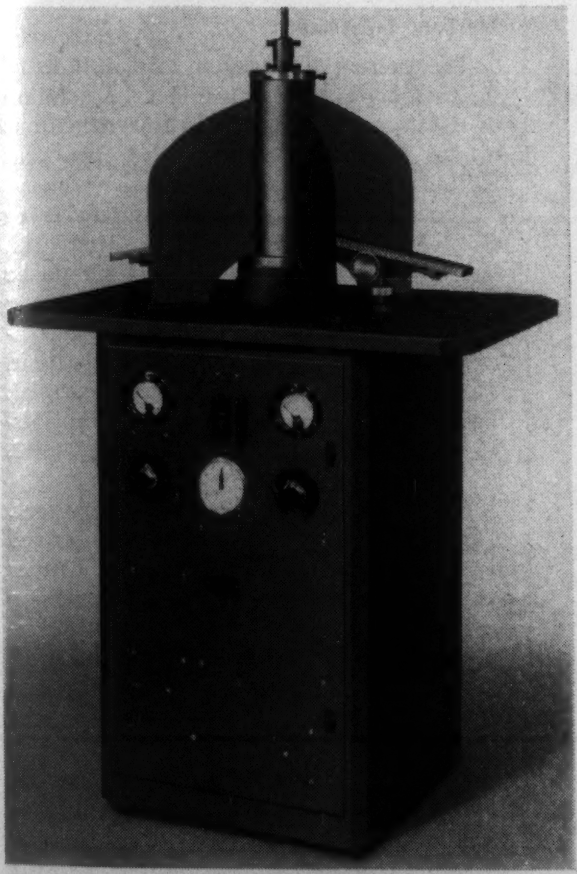
EVERY INSPECTION PROBLEM

In 1942, G-E X-Ray introduced the Semi-Automatic Unit which provides rapid, accurate production-line x-ray examination of light alloy castings or metal assemblies.



For more than 25 years G-E Engineers have designed and manufactured x-ray diffraction equipment. The G-E XRD-1 Unit is the logical culmination of these years of experience and it has been accepted by chemists, engineers, and metallurgists as unparalleled for precision research.

HUNDREDS of high-powered G-E Industrial X-Ray Units are in daily use inspecting vital materials manufactured for the United Nations. With today's increased production schedules it is necessary to insure quality, save time and cut rejects to a minimum so that the flow of essential war materials will not be interrupted.

G-E Industrial X-Ray Units are designed from the drawing board on up for *industrial* use. They incorporate x-ray transformers and tubes, controls, and mountings especially designed for industrial service. Strength and durability are built into each unit to insure a maximum of uninterrupted service.

G-E X-Ray offers you the services of its corps of industrial x-ray engineers who have a background of more than 20 years' experience in applying x-ray examination in foundries, welding shops, aircraft factories, and other manufacturing establishments. They are aware of the production and inspection problems which are encountered in modern industrial practices. You can depend upon their recommendation as to which G-E Industrial X-Ray Unit will provide complete x-ray inspection in an *economical time.* And if x-ray inspection cannot be applied effectively and economically—they will be the first to tell you.

We are interested in a G-E Industrial X-Ray Unit to examine

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☐ Zinc base castings..........inches thick.
☐ Copper base castings........inches thick.
☐ Iron base castings...........inches thick.
☐ Weldments ☐ X-Ray Diffraction

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bility, cold checks, and general workability. Since most of the company's war products will be exposed in salt-laden atmospheres, a salt spray test is also applied.

—G. E. Stedman, *Metal Finishing*, Vol. 41, 1943, pp. 391-394.

The Mercury Cracking Test

Condensed from "Sheet Metal Industries"

Widely divergent results have been obtained in the mercury cracking test due to the non-uniformity of procedure. Also, many using the test have not realized that it can not be used to assess probability of service. With these factors in mind, the author sketches the desirable features for a standard mercury test.

Degreasing must be carried out but the exact method will be a function of the nature of the lubricant to be removed. The details of pickling must be specified as differences in pickling will affect the results of the mercury test. A 30-45 sec. treatment in cold 30 per cent HNO_3 is recommended.

Provision must be made for a sufficiently large volume to be used in proportion to the surface to be treated. This dip is to be followed by instant transfer to a clean water rinse. Tarnish must be guarded against as it seriously affects the mercury test.

Mercury Treatment

The present diversity in composition of the mercury bath is unjustified. A solution of 1 per cent of the crystalline mercurous nitrate in water containing 1 per cent HNO_3 is recommended.

The best method of preparation is to moisten the crystals with the nitric acid, then to add the water. Heating should be avoided. The temperature of the test is very important; 17 deg. C. is recommended with 20 deg. C. as a high limit. The matter of replenishment is essential. The analytical control worked out by Gisser (METALS AND ALLOYS, Aug. 1942, p. 238) is suggested.

The time of immersion is also important. Although the amount of metal dissolved is simply proportional to the time, further cracking action is small after an immersion of 20 min. Therefore, a standard immersion time of 20 min. is recommended.

The effect of a resting period between removal from the mercury bath and the volatization of the mercury is important. The best way to achieve uniformity would be to insist on immediate drying and heating, although slight variations in incidence of cracking may be found caused by the varying speeds with which the rinse and drying are carried out.

Although the effect of heating temperature has been imperfectly explored, a temperature of about 260 deg. C. seems suitable and least likely to disturb results. Not less than 100 ml. of solution should be allowed for every 50 sq. cm. of surface as otherwise depletion is rapid and local exhaustion may occur.

All tested articles should be considered scrap, even if no cracking has occurred, and must not be subsequently used.

—R. G. Johnston, *Sheet Metal Ind.*, Vol. 17, Apr. 1943, pp. 645-647.

THE ROLE OF THE X-RAY IN WINNING THE WAR . . . *and after*

Only the Fit fight for Uncle Sam
. . . Thanks to the X-RAY!

Our military medical authorities demand the protection of an x-ray chest examination for every inductee into the armed forces. Thousands of cases of incipient tuberculosis are thereby discovered and eliminated—cases which, under the rigorous conditions of warfare, would develop into active sickness. This care in selection has given Uncle Sam the "fittenest, fightingest army" ever assembled.

After the war, it will be usual for school groups, large employee groups, perhaps entire populations, to receive the benefit of such x-ray examinations.

Thus, this miraculous tool of modern science, which is contributing so much to the winning of the war, by selecting men and materials fitted for the jobs they have to do, is going to contribute importantly to the better world after peace is won—a healthier world, also made happier by the material contributions of science. The use of x-rays in research, processing, and inspection, stimulated by the training of thousands of skilled x-ray technicians and the development of marvelous new x-ray instruments, will open wide horizons in many fields in the post-war world.

THE X-RAY TUBE IS THE HEART OF THE X-RAY MACHINE . . . The majority of leading makes of X-Ray apparatus are equipped with Machlett Tubes.

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METALLURGICAL ENGINEERING news

Equipment • Finishes • Materials • Methods • Processes • Products
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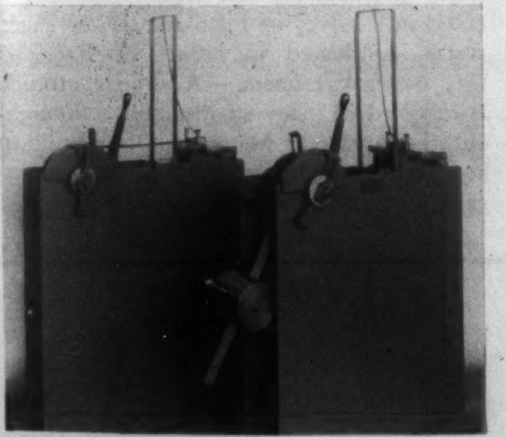
Machine for Testing Wood's Toughness

A machine for testing the toughness of wood, recently developed by the U. S. Forest Products Laboratory, is now made by *Baldwin-Southwark Div., Baldwin Locomotive Works,* Philadelphia. It discloses possible physical weakness in wood more accurately than by density and other physical property tests usually made.

Known as the F.P.L. toughness testing machine, it has proved popular in the wooden airplane industry and may be useful in laminated plastics. Compression defects resulting from proud wood and decay which might not be discovered by usual inspection methods, can be revealed. Wood toughness depends on the relation of tensile to compressive strength. When tensile strength is high for a given density, the compressive strength is low, and when tensile strength is low, compressive strength is high. Small changes in the ratio of tensile to compressive strength are accompanied by substantial changes in toughness. Incipient decay influences toughness before its effect is indicated by density.



The toughness machine operates by a falling pendulum, which breaks a wood specimen supported as a simple beam loaded in the middle. The machine has 15 different loading capacities and three speeds to rupture the specimen. Indications of the machine are converted into the number of inch-pounds of energy that are absorbed in breaking the sample. The machine must be used in conjunction with visual inspection to eliminate compression wood as well as diagonal and spiral grain.

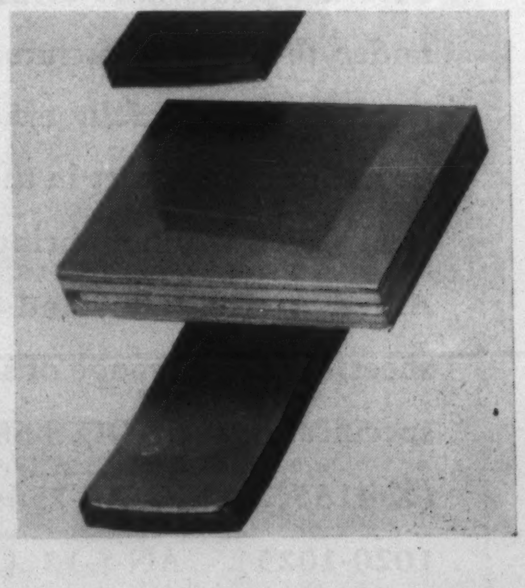
In the accompanying photograph, at the right, the machine is in position for the test; at the left, after the test is completed.

Bonding for Metals, Rubber, Plastics, Etc.

A method of bonding metal to metal, or rubber, synthetic rubber, plastics, leather or wood to metal, or to each other, with a bond usually stronger than the materials themselves, is announced by *U. S. Stoneware Co.,* Akron, Ohio. The process, "Reanite," is suitable with most all metals: Iron, steel, stainless steel, magnesium, aluminum, aluminum alloys, copper, bronze and brass. Surfaces to be joined are brushed, sprayed or dipped with Reanite. After drying, mild heat and pressure are applied.

The Reanite joint is unaffected by fresh or salt water, is non-corrosive to metals, has excellent corrosion-resistance in itself and high dielectric strength. Its strength over a range of —40 deg. F. to 300 deg. F. is stronger than bonds by conventional processes.

Present uses include fabrication of airplane, sub-assemblies, motor mounts, sound and vibration damper assemblies, instrument mounts, composite metallic and plastic units and others. Future uses foreseen include pre-fabricated housing units, metal-clad plywood for kitchen cabinets, boats, airplane assemblies, etc.



● Dies of tool steel composition made by powder metallurgy are now in successful commercial use. Their cost is in excess of ordinary powder metallurgical pieces, but considerably less than the cost of the dies they replace.

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DIVISION OF
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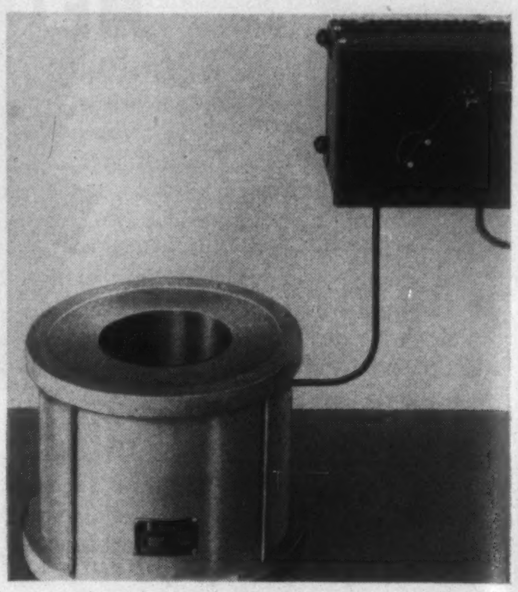
The Andrews Steel Company produces a limited range of aircraft quality alloy plates.

Bench Heat-Treat Tool Room Furnace

A versatile new tool hardening and carburizing furnace for the tool room, called the "Cub," is being turned out by *Industrial Furnace Div., Lee Grinder Co.*, 4708 Armitage Ave., Chicago. It is a compact electrically-heated bench unit for use with accelerated carburizing salts, designed to operate at a maximum temperature of 1600 deg. F.



The control unit combines switch, magnetic circuit breaker and voltage control. The work is at all times insulated from contact with air.

It can be operated intermittently or continuously on any 110-130 volt circuit, temperature being constant. There are no hot spots. The salt is heated uniformly even when the level of the bath varies widely.

Dimensions are 13⅝ in. in diam., 11 in. high. The seamless, corrosion-resistant alloy pot is 6 in. deep by 6⅜ in. in diam. Weight is 25 lbs.

● Increasing public and retail confidence in jewelry palladium as a white precious metal alternate for war-needed platinum is noted in a survey of Fifth Ave., New York, stores, conducted in behalf of *Baker & Co.*, Newark refiners. A similar attitude is reflected in many smaller stores throughout the country. Many find it difficult to keep up with demands for palladium engagement and wedding rings.

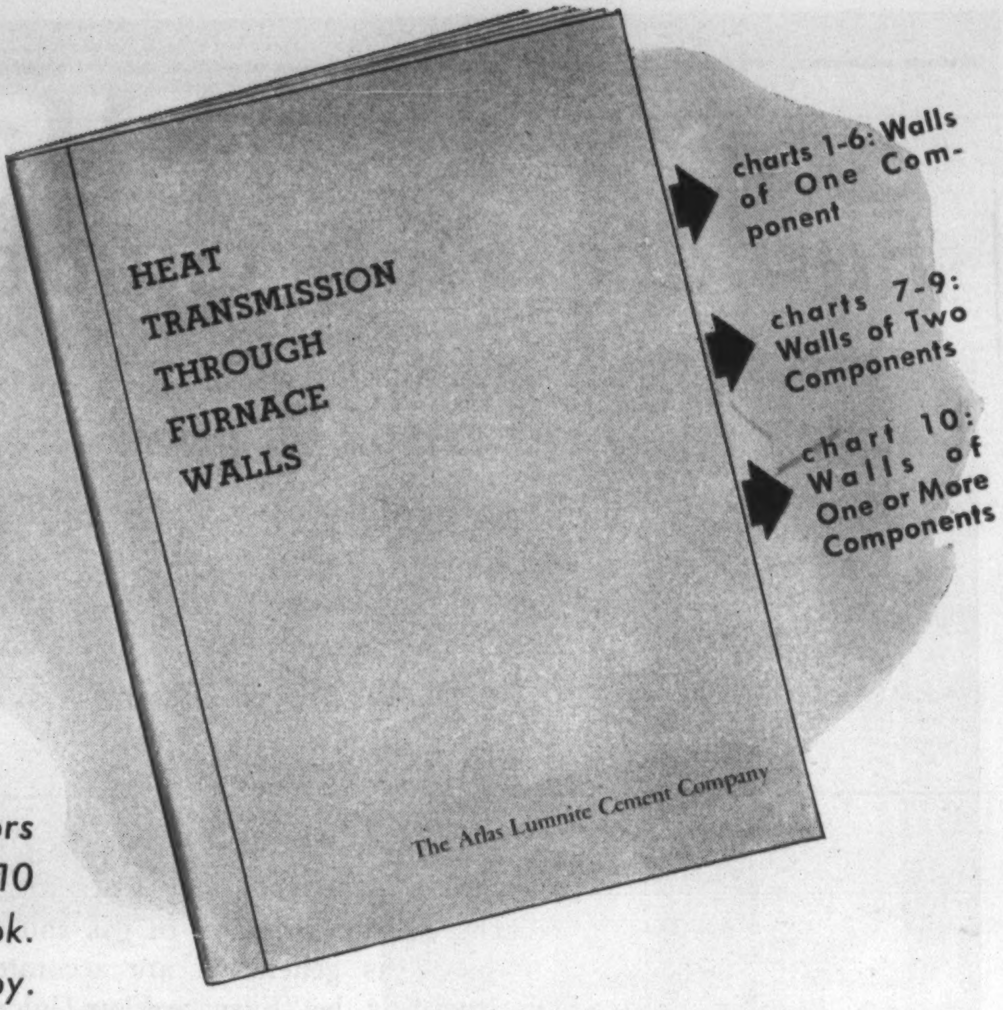
Abrasive Belt Grinders

A new improved 6 in. Wet-N-Dri abrasive belt grinder has been placed on the market by *Hammond Machinery Builders, Inc.*, 1646 Douglas Ave., Kalamazoo, Mich. Among its many features are a new, heavy, large cast base and larger sludge pan and new pulley-motor mountings, easily adjusted from outside the base.

The machine can be adjusted from vertical to horizontal while running, as can the belt tension and tracking device, by two convenient handles.

Squaring, champfering, forming radii, grinding flat surfaces, rounding, polishing and removing shaper marks are a few of the operations done on abrasive belt grinders.

NEW!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charts 1-6: Walls of One Component
charts 7-9: Walls of Two Components
chart 10: Walls of One or More Components

charts to simplify heat calculations

Furnace designers and operators can save time by using the 10 full-page charts in this new book. Send coupon for your free copy.

Just off the presses: a 16-page book of charts for rapid calculation of cold-face temperature and heat loss and for selection of efficient refractory and insulating materials. It contains useful information on the conductivity of the refractory materials commonly used in industrial furnace construction.

This new book enables the furnace designer to:

1 Determine cold-face temperature and heat loss when hot-face temperature, thickness of wall and conductivities of the materials are known.

2 Select materials and thickness of wall to give desired cold-face temperature or heat loss when hot-face temperature is known.

3 Compare efficiency of two or more materials or combinations of materials.

The 10 charts give data for walls of two or more components as well as for walls constructed with a single refractory material. The curves are plotted in terms of conductivity factors (K), and can he used in designing for most refractory and high-temperature insulating materials. Calculation of curves was based on A.S.T.M. "Recommended Procedure for Calculating Heat Loss through Furnace Walls." A chart of K-factors for several types of refractories is included.

Fill out and mail the coupon now for your *free* copy of "Heat Transmission Through Furnace Walls."

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...helps maintain proper furnace conditions

The critical flow rates of gas and air to inert gas generators are accurately measured by the "Furnace Flow-Guide." It warns the operator immediately of any change by means of the visible float which moves up or down in direct proportion to the flow rate. Its accuracy is guaranteed by the precision-bore PYREX metering tube, fashioned by the exclusive F & P "Glo-Tech" process.

The metering tube is also non-corrosive and transparent, so that the operator can tell when dirt accumulates or interferes with accurate readings. The "Furnace Flow-Guide" is readily cleaned without removing it from the line.

Flow pulsations are dampened by the oil dashpot attached to the bottom fitting of the meter.

The "Furnace Flow-Guide" is moderately priced and easily installed. It tells your operator exactly what he is doing, and standardizes the results you will obtain from day to day in your hardening and annealing processes. For full information write for Bulletin 30-C. ...

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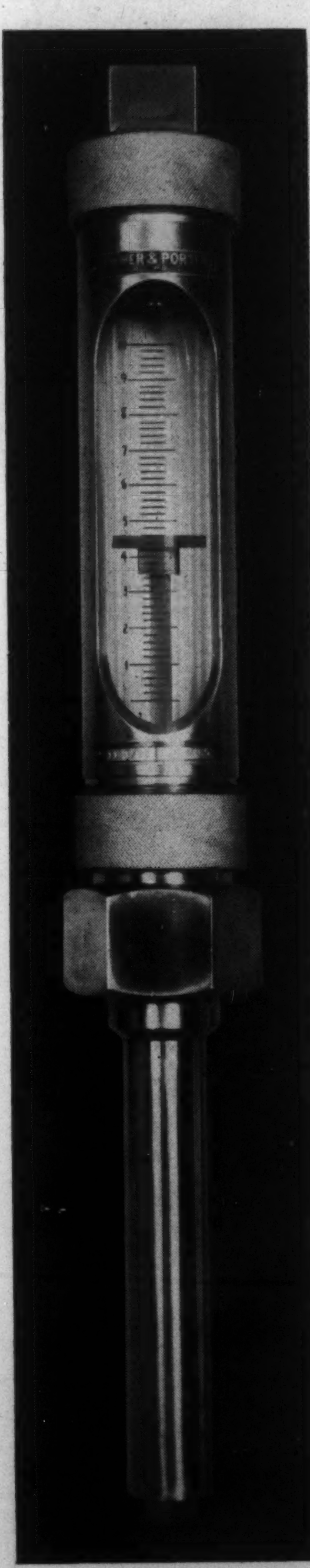
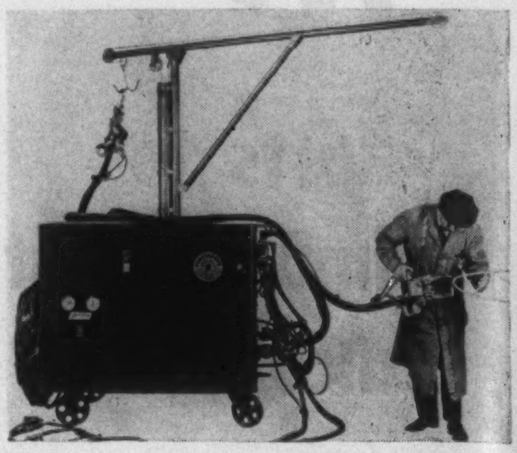
F&P ROTAMETERS



Spot-Welding Field Repair Cart

A self-contained field repair cart for repair spot-welding of steel parts of an airplane on the spot has been developed by *Progressive Welder Co.,* Detroit 12. Equipped with an electronic timer and wide selection of both air-operated and manual "tong" type guns, the cart can do most all spot welding jobs on stainless and other light gage steels.



Refrigeration of transformers, cables and guns eliminates the need for external water connections, the condenser in the "Frostrode" refrigerating unit being air-cooled. The refrigerant circulates a coolant through transformer, cables and guns. The only needed connection to the cart is a power lead.

Cables are of the Progressive (P H) concentric kickless type. A large variety of electrodes may be mounted in the guns, and it is possible to weld in almost any position.

● A new method of protecting fine cutting tools in shipment and storage was developed by the *Robert H. Clark Co.,* 3424 Sunset Blvd., Los Angeles. The company does not make them, but passes along the idea. The new lightweight container employs two softwood blocks in a cardboard box. One block is drilled to serve as a base for the cutting edges of the tool, while the other is drilled to fit the shank. After shipping, the container can be used as a handy tool crib for storage.

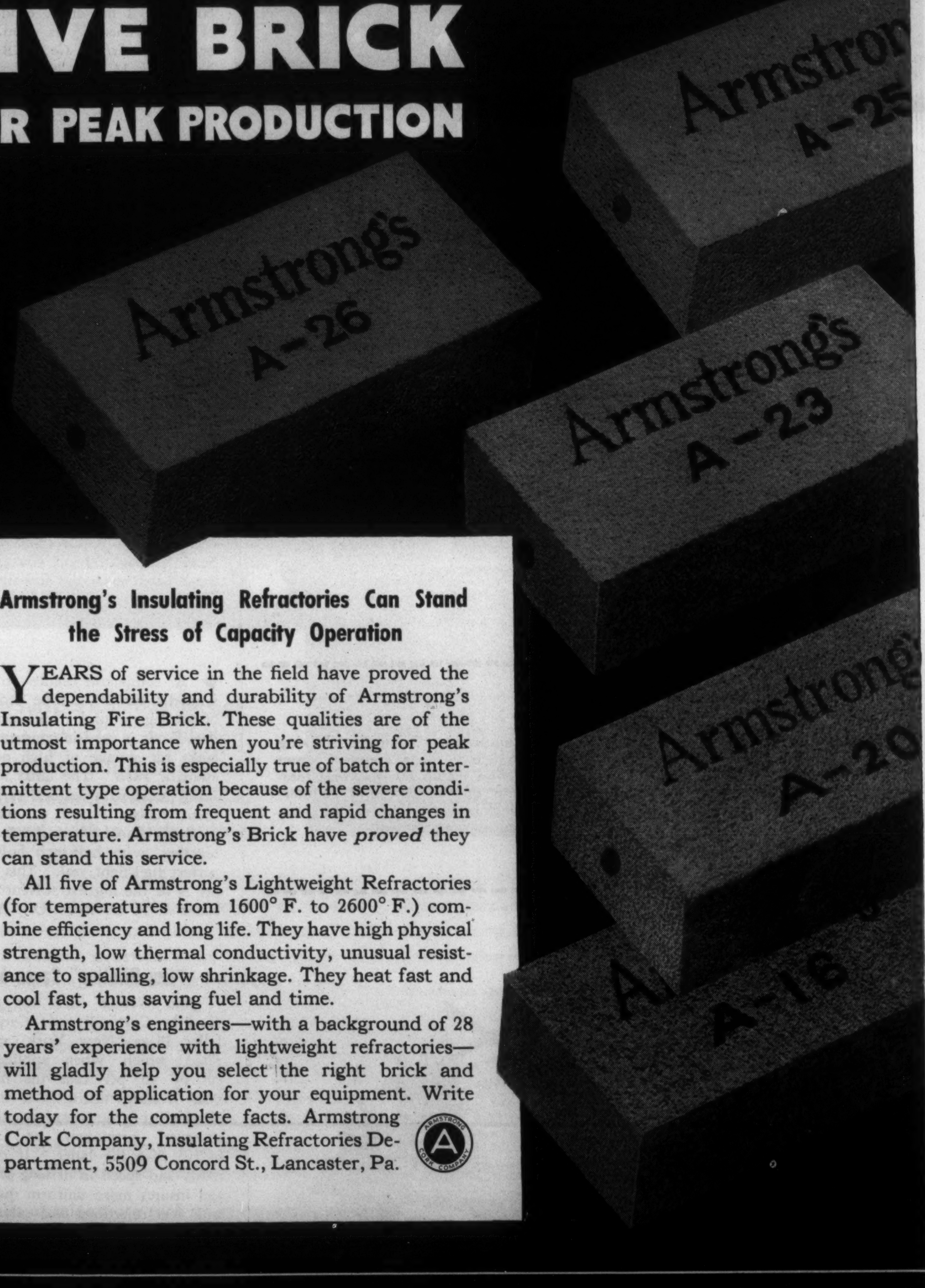
Vibration Fatigue Testing Machines

An addition to their line of vibration fatigue testing machines, Model 100, has been added by the *All American Tool & Mfg. Co.,* 1014 W. Fullerton Blvd., Chicago. It will handle parts or assemblies up to 100 lbs. The table has an area of 15 x 18 in., and has 115 tapped holes for bolting on objects. Table movement is horizontal.

The frequency is adjustable while the machine is running, from 10 to 60 cycles per sec. (600 to 3,600 vibrations per min.), and is recorded on an electric tachometer.

It is designed for use in laboratories or inspection departments to test fabricated airframe and aircraft engine parts, navigation instruments, radio and electronic equipment, molded plastic parts, foundry cores to determine strength, packaging to determine resistance to vibration, etc.

FIVE BRICK
FOR PEAK PRODUCTION



Armstrong's Insulating Refractories Can Stand the Stress of Capacity Operation

YEARS of service in the field have proved the dependability and durability of Armstrong's Insulating Fire Brick. These qualities are of the utmost importance when you're striving for peak production. This is especially true of batch or intermittent type operation because of the severe conditions resulting from frequent and rapid changes in temperature. Armstrong's Brick have *proved* they can stand this service.

All five of Armstrong's Lightweight Refractories (for temperatures from 1600° F. to 2600° F.) combine efficiency and long life. They have high physical strength, low thermal conductivity, unusual resistance to spalling, low shrinkage. They heat fast and cool fast, thus saving fuel and time.

Armstrong's engineers—with a background of 28 years' experience with lightweight refractories—will gladly help you select the right brick and method of application for your equipment. Write today for the complete facts. Armstrong Cork Company, Insulating Refractories Department, 5509 Concord St., Lancaster, Pa.

ARMSTRONG'S INSULATING REFRACTORIES

Lancaster MIXERS

THE SCIENTIFIC COUNTER-CURRENT RAPID BATCH MIXING SYSTEM

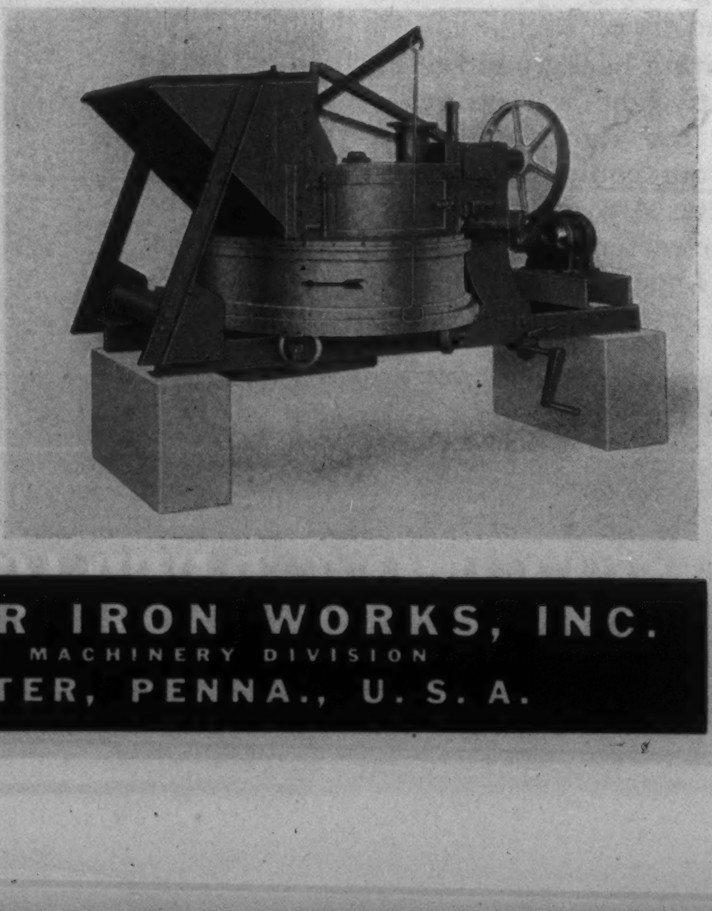
"LANCASTER" PRECISION IS THE "PRICELESS INGREDIENT" IN MIXING

FOR POWDER METALLURGY... FOUNDRY SANDS... REFRACTORIES... "Lancaster" Mixers provide the precision and dependable uniformity that improves man-hour productivity... help conserve critical materials... simplify processing methods.

The basis of the "Lancaster" System is counter-current mixing on a horizontal plane PLUS balanced mulling action. Particles are uniformly distributed regardless of variations in size, weight or physical characteristics... segregation is avoided... liquid additions dispersed with startling perfection.

In war essential industries, "L" Mixers are providing that priceless ingredient—precision mixing. They are available in 9 unit sizes and 32 models. Recommendations to suit your individual requirements submitted promptly upon request. No obligation.

Lancaster's Scientific Mixing System... a counter-current action set up by clockwise rotation of the pan and counter-clockwise rotation of the mixing star equipment.



Lancaster Mixer, Symbol EMG-4, closed pan type, fitted with full batch stationary hopper.

LANCASTER IRON WORKS, INC.
BRICK MACHINERY DIVISION
LANCASTER, PENNA., U. S. A.

New Projector with Larger Lens

A new model of Wilder projector, containing a 2 in. diam. condenser in place of the previous 1½ in. diam., is announced by *George Scherr Co.*, 128 Lafayette St., New York 13. This provides a larger beam of parallel light, permitting use of larger diameter lenses in the lower-power series. The diameter of the new 10 X lens is 1⅜ in. and that of the new 20 X lens, 13/16 in.

There are also a newly designed, fully enclosed head, with a more streamlined and better ventilated lamp house. Spiral gears are now used in the focusing motion and the lenses are set in larger and heavier mounts.

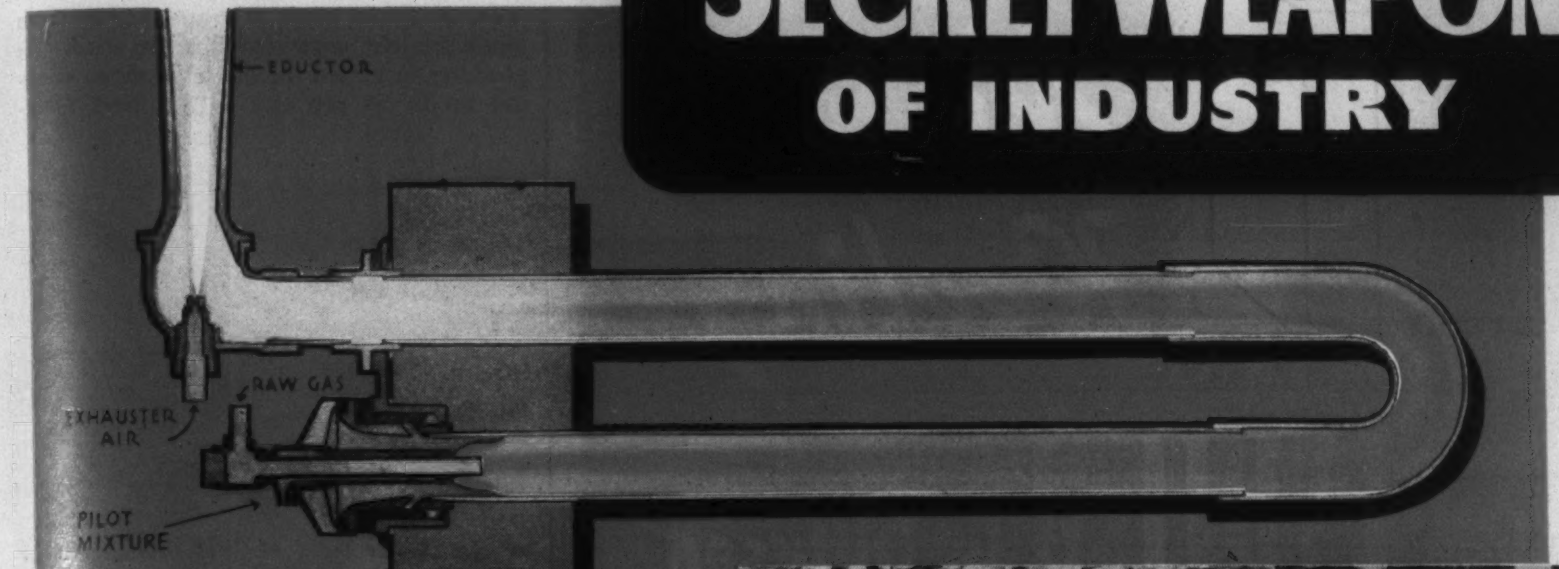
● A compound made from Ameripol, synthetic rubber, can be bent at an angle of 90 deg. around a half-inch rod at —70 deg. F. It is used in construction of bolted tanks for storage of high octane gas and aromatic fuels. The tanks are made from sheet metal with sealing strips of the synthetic rubber 1 3/4 in. wide and 3/32 in. thick, placed where the sheets are bolted together, with half-inch bolts, assuring a perfect fuel-tight seal. This synthetic rubber is of the highest solvent resistant type, states *B. F. Goodrich Co.*, Akron, O.

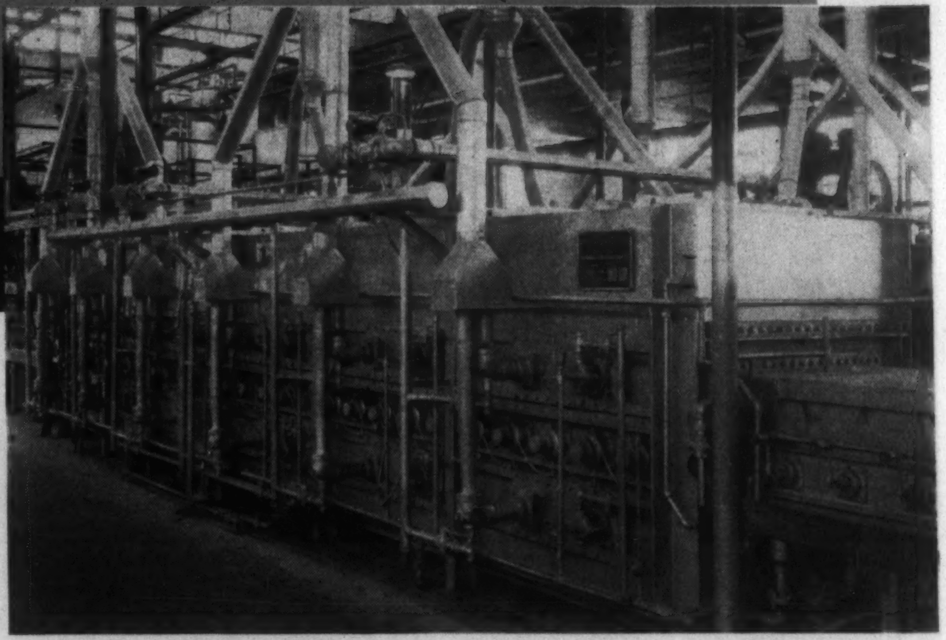
"Jam Riveting" Saves Manpower

"Jam riveting" is a new process developed by *Curtiss-Wright Corp.*, 30 Rockefeller Plaza, New York, at its Buffalo plant, which, when applied fully, will cut by 40 per cent the number of 2-man riveting teams. It eliminates the "bucker" of the team as did the "gang squeezer" previously, and is more effective than the latter. It combines flexibility and speed in driving warplane rivets and insures more uniform quality of work with less rejections and salvage.

It consists of a regular vibrator with added attachments, so that its action is controlled automatically by the "travel" of the driving set. It is designed to work on curved cowling, etc. where gang or individual "squeezers" cannot operate. One adaptation is a hand tool vibrator with adjustable depth timer attached to a hinged yoke. The second is a vibrator adapted to a special yoke fabricated from cold-rolled steel and mounted on a pedestal.

SECRET WEAPON
OF INDUSTRY





A Typical Furnace Application of Surface Combustion Radiant Tubes

The Surface Combustion gas-fired radiant tube is a revolutionary production tool. It is a very fast, very accurate heating element, easily controlled and with a high output.

● The long and highly radiant luminous gas flame, which is a result of streamlining the flow of air and gas in parallel formation, without turbulence, is so produced to extend practically the entire length of the tube. A uniform, radiant heat from end to end is the final result.

● A negative pressure or suction is produced by the eductor at the discharge end of the tube. This makes it impossible for the products of combustion to escape into the furnace, should a leak develop in the tube. Hence, where special atmospheres are needed, expensive alloy muffles are no longer necessary.

● The results obtained are such an improvement over old heat treating methods that more than a total of 55 miles of these tubes have been installed in the majority of plants where refined heating is now practiced. They are used in practically all heat treating processes: *Malleableizing, Bright Annealing, Bright or Clean Hardening, Deoxidizing, Carburizing, Drawing, Normalizing, Spheroidizing,* etc., and have been of particular value in *heat treating aluminum and magnesium.*

● These Surface Combustion radiant tubes are being used in practically every kind of heat treating furnace ...standard furnaces and special prepared-atmosphere furnaces...in both batch and continuous processes... treating finished parts, as well as strip, sheet, coil, tin plate, tube, rod, wire and bar stock...not only steel and steel alloys but brass, copper, aluminum, magnesium, nickel-silver, cast iron, other ferrous and nonferrous products and glass, enamel and ceramics.

● If you are interested in faster, heat treat production, a more uniform, improved heating method, at less expense, call or write us for complete facts.

SURFACE COMBUSTION • TOLEDO, OHIO

SURFACE COMBUSTION

INDUSTRIAL FURNACES • JANITROL GAS-FIRED SPACE HEATING EQUIPMENT • KATHABAR MOISTURE CONTROL SYSTEMS

No Peeling—

when INDIUM is Diffused into Brass, Bronze or Copper Surfaces

INDIUM, applied electrolytically to surfaces and then diffused, protects by alloying rather than plating.

What are the results?

The INDIUM-diffused surface takes on a greater hardness than the untreated surface, thus making the treated part very useful for bearing or other wearing service. It can be buffed to a higher color. Its resistance to corrosion is greater than the original metal, providing more permanent decorative color and brilliancy. The surface is homogeneous and continuous; free from cracks and pin-holes.

If you are working with brass, bronze or copper and want a better finish, investigate the possibilities of INDIUM. When writing, please outline your problem so that we may answer your inquiry intelligently.

ARMY E NAVY

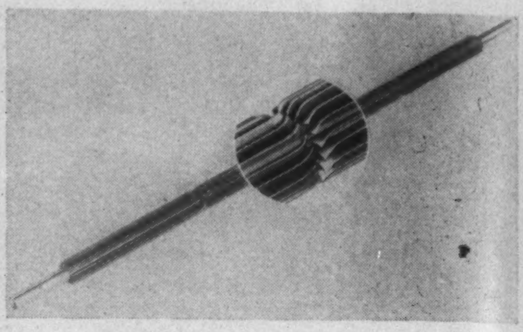
THE INDIUM CORPORATION OF AMERICA
Pioneers In 49

The INDIUM Corporation of America
UTICA, N. Y.
New York Office: 60 East 42nd Street

9-10-1

Heat Exchanger Fintubes

"Cut and twisted" fintubes, such as made by *Brown Fintube Co.*, Elyria, Ohio, are said to produce much greater turbulency of the shell side commodity than when straight untwisted fins are used. It produces increased thermal efficiencies ranging up to 50 per cent in Sectional Hairpin and other types of heat exchangers in which the shell side commodity is held closely against the fintube, resulting in still further savings in weight, pressure drop, shipping, etc.



Generally, one linear foot of Brown resistance-welded, integrally-bonded fintube provides the heat transferring capacity of from 6 to 10 ft. of plain bare tubes. This results in substantial savings when effecting heat transfers between commodities having unequal heat transfer coefficients.

● A composite steel that saves high speed and other alloy steels from 50 to 80 per cent has been brought out by *Jessop Steel Co.*, Washington, Pa. It consists of a section of alloy steel continuously and permanently bonded to a backing of mild steel. Proportions of the alloy section are controllable. The steel, in bar form, can be machined along the entire length to specifications for a forming tool, then cut into desired lengths for individual tools, eliminating separate machining of each tool.

Gun for Driving Blind Rivets

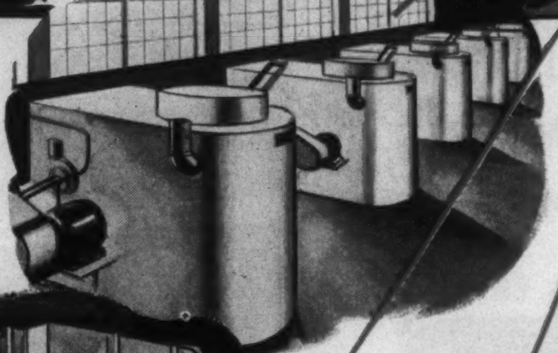
A new gun for high-speed application of blind rivets, which has been simplified to make fewer parts in the power linkage, is the Cherry rivet G15 power gun for application with Cherry rivets in double-surfaced structures where access to one side of the work is obstructed. The tool will install rivets at the rate of 1600 per hr.

It is an all-pneumatic gun, with general refinements to make a smooth acting, better balanced tool. Cast aluminum, steel and bronze are used in its construction, weighs 4½ lbs. and operates on 75 to 100 lbs. per sq. in. pressure.

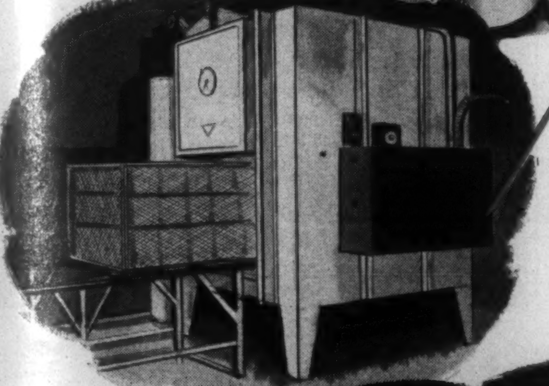
Three interchangeable pulling heads handle the three standard diameters of Cherry rivets — 1/8, 5/32 and 3/16 in., either hollow or self-plugging types. Clearance around the rivet axis is 3/8 in. The tool operates equally well in any position.

It is made by the *Cherry Rivet Co.*, 231 Winston St., Los Angeles.

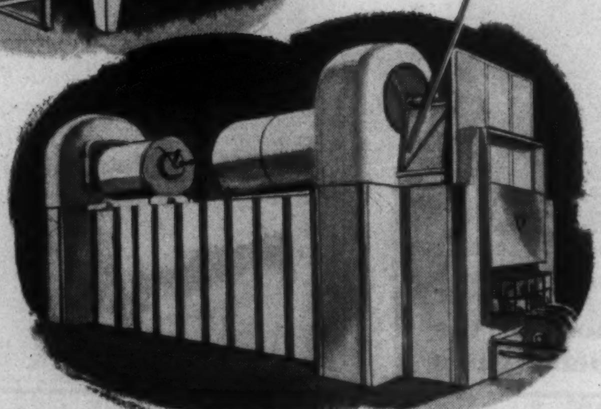
WHICH DESPATCH FURNACE IS BEST FOR MY JOB?



Pot-type furnaces; electric, gas or oil-fired; to 1250° F. Basket-diam. to 94"



Batch-type furnaces in standard sizes from 13"x13"x13". Electric, gas or oil-fired. Convection heated.



Conveyor type furnaces for volume production. Uses any fuel. Entirely automatic in operation.

No trigger-quick answer to this question will you get from a Despatch engineer. He knows, as you do, that the best Despatch furnace for your particular needs cannot be a subject of snap judgment nor be decided from an arm-chair.

Instead, our engineer first asks *what* you want to accomplish, *where* it is to be done, and *how* you wish to proceed. Then, after a careful, unbiased check-up of your plant, he recommends the Despatch furnace which will do *your* job most effectively and at lowest cost.

6-Point Plant Survey . . . FREE

Here are the chief points which a Despatch engineer considers in determining the furnace to recommend:

1. Process involved
2. Material handled
3. Production desired
4. Space requirements
5. Labor available
6. Fuel to be used

Assures Better Production at Less Cost

Direct result of this on-the-job survey is to your advantage, and ours. *You* get the right Despatch furnace to give you most production and highest quality at lowest operating cost . . . a furnace that is ideally suited to your plant set-up in every way, with ample reserve capacity for tomorrow's even bigger postwar jobs. And we? Well, we have one more *completely* satisfied customer whose confidence we have honestly earned.

WIRE, PHONE OR WRITE TODAY!

DESPATCH
OVEN COMPANY MINNEAPOLIS

DESPATCH ENGINEERS IN THESE CITIES

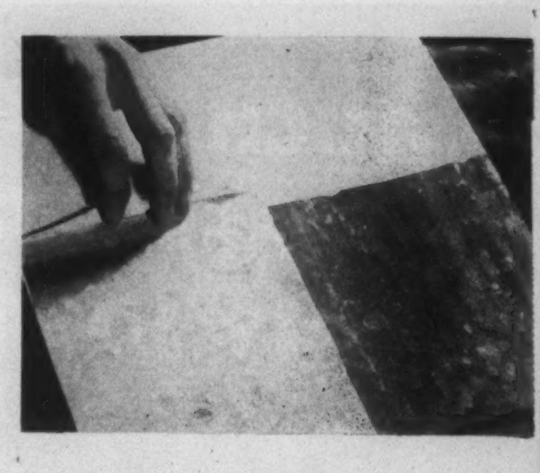
ALBANY, NEW YORK
BIRMINGHAM, ALABAMA
BLUEFIELD, WEST VIRGINIA
BOSTON, MASSACHUSETTS
BUFFALO, NEW YORK
CHICAGO, ILLINOIS
CLEVELAND, OHIO
DALLAS, TEXAS
DAYTON, OHIO
DETROIT, MICHIGAN
INDIANAPOLIS, INDIANA
LOS ANGELES, CALIFORNIA
MILWAUKEE, WISCONSIN
NEWARK, NEW JERSEY
NEW ORLEANS, LOUISIANA
OAKLAND, CALIFORNIA
PHILADELPHIA, PENNSYLVANIA
PITTSBURGH, PENNSYLVANIA
PORTLAND, OREGON
SEATTLE, WASHINGTON
SPOKANE, WASHINGTON
ST. LOUIS, MISSOURI
TOLEDO, OHIO
TULSA, OKLAHOMA
WALLINGFORD, CONNECTICUT
SAN LUIS, MEXICO

Preparation for Painting Galvanized Metal

Permanent paint adhesion on galvanized metal, with no chipping or peeling, is claimed by preparing the galvanized surface with Redi-Paint, made by *Turco Products, Inc.*, 6135 S. Central Ave., Los Angeles. This passivates or "cools" the "hot galvanizing" so that the paint will hold.

One feature is color control: A dark tint develops on areas properly treated, leaving the untreated area conspicuously bright, whereas previous treatments didn't provide for such easy distinction. Paint peels or chips from galvanized metal because of the smooth, spangled surface and the alkaline surface condition (zinc hydroxide). Formerly painters cooled the "hot" galvanizing with vinegar, or its equivalent, but this gave only temporary protection.

The new compound displaces the slick oily surface with a roughened "toothy" surface. It neutralizes the alkalinity and passivates the metal instantly. It is applied by hand or tank immersion.



In the accompanying photo, the right-hand section shows the dark color of the Redi-paint and its subsequent paint coat.

Cleaning Machine for Airplane Castings

To speed-wash, rinse and dry miscellaneous airplane castings up to 17 by 36 in., *Alvey-Ferguson Co.*, 75 Disney St., Cincinnati, has especially constructed a metal products cleaning machine, which is somewhat similar to the company's standard-type equipment.

It is equipped with 36-in. wire mesh conveyor and combination skim box, drain and overflow. The fan-shaped super-spray has a high coefficiency of cutting action. The pumps and nozzles are protected by screen tanks with removable screens.

Other features include parallel welded steam coils; unit model pump with no flexible couplings or sub-bases; marine-type clean-out and inspection doors, requiring no tools for operation; gear head conveyor motor; shear pin hub conveyor drives; spring loaded conveyor take-ups; and solution thermometer.

- To replace rubber in many aeronautical uses a new material, bound hair, has been developed by the *Firestone Tire & Rubber Co.*, Akron, O. It is composed of animal hair mixed with a little reclaimed rubber. It is used in parachute back fillers, parachute seats, pilot seats and bombardier pads.

Outdoor A.C. Welder

A new 500-amp. outdoor a.c. welder is announced by *General Electric Co.*, Schenectady, for use in shipyards and other outdoor locations. It has a welding current range of 100 to 625 amp. at 40 volts.

An interesting feature is the "idlematic" control, which automatically reduces the output voltage to under 35 volts whenever the arc is not in operation, yet provides full power for welding the instant the arc is struck.

It is protected against the entrance of "weather" by drip-proof construction of all openings in the top of the case and by a sealed window over the current indicator. Wide louvers not only shed water but keep air velocity low. All internal parts have a special finish against corrosion.

How to Control
CO₂ PERCENTAGE...
the VITAL FACTOR in ATMOSPHERE HARDENING

0
5
10
15
20
OPM

THE ENGELHARD FLUALYZER provides the answer to the long felt need for an accurate, easy-to-use method for the determination of CO_2 percentage in oxidizing and reducing gases used in atmosphere-type treating furnaces.

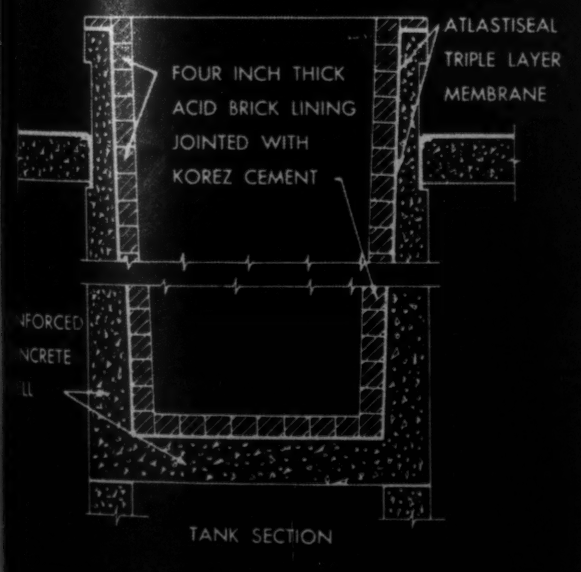
The Flualyzer is a portable, self-contained, extremely sensitive instrument which measures CO_2 content by the thermal conductivity principle of gas analysis . . . By its use, totally unskilled operators can keep a constant check on the efficiency of the atmosphere-producing burners.

For increased uniformity and quality of heat-treated and carburized parts, it will pay you to write for specific details on the Engelhard Flualyzer *today!*

Ask for Bulletin 700

CHARLES ENGELHARD, INCORPORATED
90 CHESTNUT ST., NEWARK, NEW JERSEY

GANGWAY...FOR FIGHTING CORROSIVES



nks are of reinforced concrete, acid-proofed with ng of ATLASTISEAL Triple Layer Membrane and a thick brick lining, joined with KOREZ, one of five cial ATLAS Acid-proof Cements, each designed withstand one or more corrosives, alkalis, etc.

OBSOLETE TANKS AND CHEMICAL EQUIPMENT ARE A HANDICAP AND MAY BE DANGEROUS, AS WELL AS COSTLY

THIS 87-TANK ATLAS-BUILT BATTERY
in one of the newer war-production plants
HANDLES CORROSIVE ACIDS
AND SALT SOLUTIONS
at High Temperatures

The use of readily available ATLAS Materials delivered:

- LARGE SAVINGS IN CONSTRUCTION TIME
- ABILITY TO WITHSTAND SEVERE MECHANICAL ABUSE
- ADEQUATE RESISTANCE TO HIGH TEMPERATURES
- FREEDOM FROM SOLUTION CONTAMINATION

If your production involves the storage and handling of acids, alkalis and other fighting chemicals . . . and if you are in the market for new equipment or replacements, look to ATLAS for

COMPLETE ACID-PROOFING SERVICE

- MATERIALS OF CONSTRUCTION
- TIME-TRIED AND PROVEN DESIGN . . . *and*
- SUPERVISION OF CONSTRUCTION, *if desired*

At your service here is wide engineering experience, plus centralization of responsibility which dismisses alibis. • Address our nearest office, or for Technical Bulletin No. TV—5A, write us here at Mertztown, Pa.

THE ATLAS MINERAL PRODUCTS COMPANY OF PENNSYLVANIA, MERTZTOWN, PA.

*ATLANTA 3, Georgia, 610 Red Rock Bldg.
PITTSBURGH 10, Pa., 4656 Old Boston Rd.
NEW YORK 16, N. Y., 280 Madison Ave.
*DALLAS 5, Texas, 3921 Purdue St.
*CHICAGO 1, Illinois, 333 No. Michigan Ave.
TORONTO, ONTARIO, McRae Engineering Equipment Ltd., 11 King St. W.
*KANSAS CITY 2, Kans., 1913 Tauromee Ave.
*DETROIT 2, Michigan, 2970 W. Grand Blvd.

THE ATLAS MINERAL PRODUCTS COMPANY OF CALIFORNIA, REDWOOD CITY, CAL.

*DENVER 2, Colorado, 1921 Blake Street
*SEATTLE 4, Washington, H. D. Fowler Company, 558 First Avenue, South
*HONOLULU 2, Hawaii, U. S. A.
*LOS ANGELES 12, Cal., 817 Yale Street

*Stocks carried at these points

Streamlined Laboratory Furnaces

A complete new line of laboratory furnaces, new in appearance and construction, has been developed by the *Lindberg Engineering Co.,* 2444 W. Hubbard St., Chicago 12. The line includes such types as box furnaces for drying precipitates, ash determinations, fusions, ignitions, etc.; the combustion tube for carbon determination, standard combustion, organic analyses, etc.; the crucible furnace for melting base metals, thermocouple calibrations, molten salt baths, etc.; and hot plates for heating, distilling, boiling, evaporating, etc.

They incorporate convenient door operating mechanisms on the box furnace, which permits cooler working conditions; low voltage, high temperature type heating elements; the use of a Lindberg input control for smooth, "stepless" apportioning of heat; and the clean, streamlined shape which matches other modern laboratory equipment as well as contributing to the high standard of laboratory cleanliness. The furnaces are available in different sizes for operation on 110 or 220 volt a. c. or d. c. current.

● Impellers for airplane superchargers made by *General Electric Co.* "grow" 0.003 in. when they are tested in a specially-constructed heavy steel case at speeds of more than 20,000 r.p.m. The terrific centrifugal stresses make the aluminum alloy impellers take on a permanent set and become 0.003 in. larger in outside diameter than before the test. The case is exhausted to a high vacuum for each test so that the power needed to drive the impeller is relatively small.

Metal Washing Machines

Designed to meet the need for high-speed washing of flat, fragile work or circular parts with intricate pockets and crevices, the Tabl-Spray metal washing machine has been developed by *American Foundry Equipment Co.,* 555 S. Byrkit St., Mishawaka, Ind. Typical cleaning applications include removing lapping compound, oil and chips from magnesium and aluminum aircraft parts, and cleaning crankcases, supercharger rear housings and adapters, small assemblies, gears and rocker arms prior to inspection or after Magnaflux.

Parts are placed on the mesh table and rotated through the spray solution, discharged from special machined non-clogging nozzles. After proper washing time, the solution valve is closed and the parts are left rotating for drainage.

Rinsing with fresh water can be done without transferring parts. A compressed air blow-off can follow cleaning to remove excess liquid. Straining devices settle out all chips or foreign matter. It operates with either an alkali washing solution or with a solvent emulsion.

Parts measuring 25 in. in diam. and 12 in. high can be handled on the standard machine. Machines with 30 and 42 in. diam. tables for larger work are available.

● Rubber heels that conduct electricity instead of insulating against it, are announced by *Goodyear Tire & Rubber,* Akron, O. They are of special benefit to workers in gun powder plants and other explosive lines, since static electricity within a worker's body is carried off almost at the time of inception. They are built with brass washers instead of conventional steel to provide better adhesion with the rubber.

We Solve Your TOUGH
Metal Cleaning or Finishing Problems
For
QUICK ACTION
write, wire or phone
HOWARD

HOWARD maintains a fully equipped experimental department which has solved the cleaning and finishing problems of many plants in various industries. Send us essential details of your problem and a sample of your work . . . or have our engineer call. We'll process the parts and recommend correct methods, materials and machinery—WITHOUT COST OR OBLIGATION.

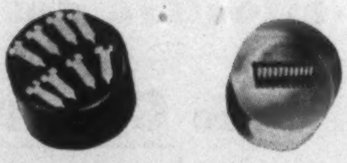
HOWARD Engineering & Mfg. Co.
1064 HULBERT CINCINNATI 14, OHIO
PRODUCTION MACHINERY FOR METAL CLEANING

This Conveyor Wash, Rinse and Hot-Air Dryer is a typical result of the above service. Specially designed and built by HOWARD to wash brass and aluminum parts. Latest in methods and design provide greater efficiency in cleaning and drying.

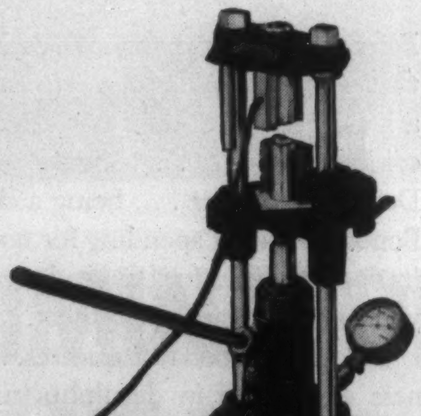
Write for New Catalog

Metallurgical
**TESTING
EQUIPMENT**

**Designed for Speed
and Accuracy**



Bakelite and Transoptic mounts are quickly and accurately polished with the new De Luxe Polishing Stand No. 1516. The personal comfort and convenience provided by the De Luxe Polisher speeds production.



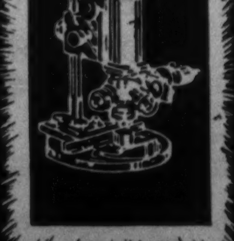
AB specimen Mount Press. No. 1315 with built in solid heating and split cooling units.

Daily contact with the problems of the metallurgist, over a period of years, enables our organization to design the right tools for each specific job. This specialization in the manufacture and distribution of equipment for all needs, means that Adolph I. Buehler provides one reliable source of supply for everything required by the modern metallurgical laboratory.

A complete line of equipment for the Metallurgical Laboratory

SPECIMEN MOUNT PRESSES • POLISHERS • POLISHING ABRASIVES • POLISHING CLOTHS • POWER GRINDERS • BELT SURFACERS • CUT-OFF MACHINES • HAND GRINDERS • CARBON METERS COLORIMETERS • HARDNESS TESTERS • DUST COUNTERS • DILATOMETERS • EMERY PAPER GRINDERS • LABORATORY CHAIRS • TITRATORS • MAGNIFIERS • METALLOGRAPHS • MICROSCOPES • STEREOSCOPES • PYROMETERS • REFRACTOMETERS • SPECTROGRAPHS • MACRO CAMERAS

Adolph I. Buehler
OPTICAL INSTRUMENTS ★ METALLURGICAL APPARATUS
228 North LaSalle Street, Chicago, Illinois



Testing Metal Strains with Lacquers

By coating armor plate with a certain lacquer and then firing a bullet, "footprints" are left in the form of thin, closely-spaced cracks, which denote stretching of the metal underneath the lacquer and give a permanent picture of the strains that occurred at the instant of impact. Such studies are being made by Dr. Mikles Hetenyi in the *Westinghouse* Research Laboratory.

Some shots create a heart-shaped pattern extending 6 to 8 in. from the bullet penetration. In other tests the cracks form a series of circles around the bullet hole.

By spraying this lacquer, "Stresscoat," on metal parts and then contorting them until the brittle skin cracks, one can also detect vulnerable spots in gears, shafts, valves and other parts. The cracks may be compared with fissures in the earth's crust caused by earthquakes, revealing where faults are deep underground.

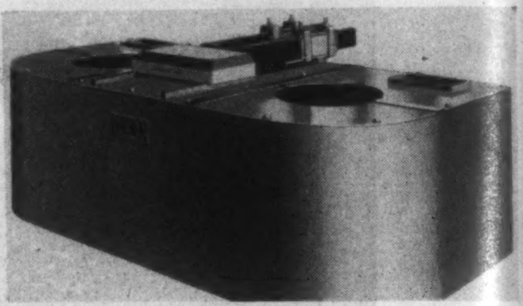
Lacquer sprayed on a gear tooth, for instance, dries in 15 hrs. to form a tightly clinging skin with thickness of a human hair. To determine the least strain that will crack this coating, a foot-long steel bar is sprayed at the same time as the gear tooth. The steel bar is bent in a machine that holds it rigid at one end and depresses it at the other.

Most of the cracks appear at the rigid end, becoming less frequent until there are none at the opposite end. The bar is placed beside a strain scale, which is read opposite the last crack, the reading indicating the minimum strain.

The coated gear tooth is given the same punishment it would get when in actual work. It is squeezed in a press capable of 400,000 lbs. Finally, the research men have a progressive list of the tooth's weak points.

Three-in-One Heat Treat Unit

Here is a 3-in-1 high speed heat treating unit, consisting of three pots, with different temperature ranges, made by *A. F. Holden Co.*, New Haven, Conn. Pot No. 1, with a range of 1400 to 1800 deg. F., is for preheating high speed tools, for heating water and oil hardening steels, alloy steels such as high carbon-high chrome or stainless types, for carburizing and for silver soldering.



Pot No. 2, with a range of 1900 to 2350 deg. F., is for hardening all types of high speed steels, for copper brazing and for heating forgings. No. 3, with a range of 1000 to 1400 deg. F., is for quenching high speed tools from the hardening temperatures, for tempering, nitriding, blueing and for descaling forgings and similar parts. The company lists seven advantages.

● A new spray-degreasing booth, announced by *De Vilbiss Co.*, Toledo, Ohio, holds solvent loss to barest minimum. It removes fumes more thoroughly and delivers a more forceful, harder-driving solvent spray than formerly.

Hydraulic "Junior" Presses

A new line of "Juniors" in the hydraulic press line is announced by the *Colonial Broach Co.*, Detroit 12. Of 1-ton capacity, they are now available as base-type machines in addition to the bench models. They are available for the "pull down" type of broaching operations, with the puller mechanism and coolant tank in the base.

They differ from the larger Colonial presses mainly as to capacity and size. Pumps and reservoir for the hydraulic fluid are incorporated in the main body of the press. Ram speed is 30 ft. per min. downwards, or ideal for broaching and assembly. A high-speed return of 60 per min. is provided for the upstroke.

for **economical,**

effective desulphurizing . . .

use Columbia

soda briquettes

Before we tell you about Soda Briquettes, may we remind you that *America needs your help every day?* It may mean working a little harder or longer on the job . . . avoiding the waste of critical materials . . . giving up some spare time to Civilian Defense activities . . . being a Blood Donor . . . saving in War Bonds instead of spending for non-essentials. Each day presents its opportunities for being a better American. We sincerely urge you to take advantage of them.

And now—Soda Briquettes. They're proving their effectiveness every day in desulphurizing iron, quickly and cheaply. Substantial reductions are being recorded depending, of course, on the height of original sulphur; the amount of material used per ton of iron; the amount of contact produced between iron and treating materials.

Soda Briquettes are merely added to the ladle at the time of casting. If you are not using them and you have high sulphur conditions to overcome, phone or write our nearest office for complete details.

PITTSBURGH PLATE GLASS COMPANY
COLUMBIA CHEMICAL DIVISION
GRANT BUILDING • PITTSBURGH (19), PA.

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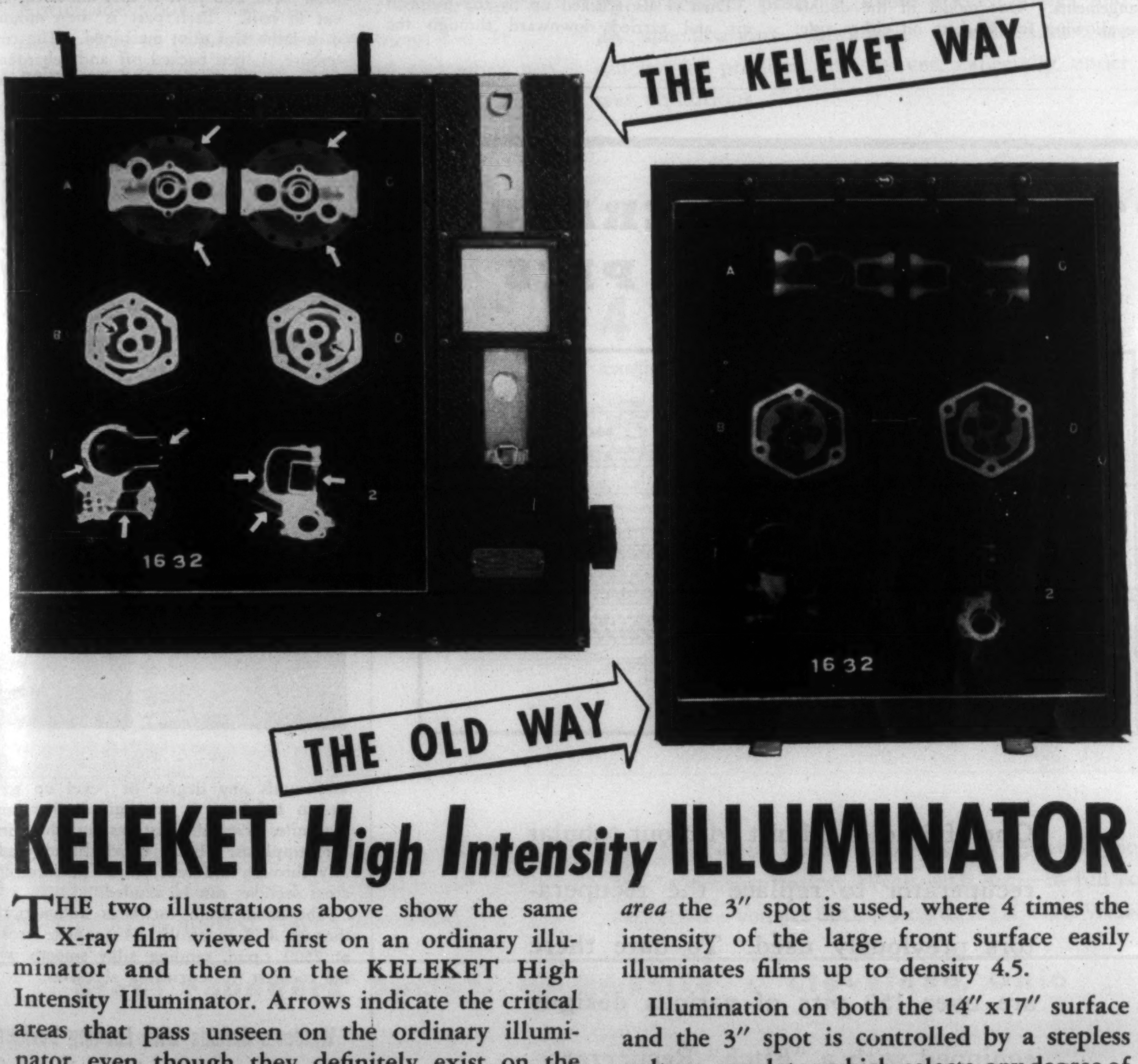
4 TIMES MORE ILLUMINATION FOR VIEWING INDUSTRIAL RADIOGRAPHS



KELEKET *High Intensity* ILLUMINATOR

THE two illustrations above show the same X-ray film viewed first on an ordinary illuminator and then on the KELEKET High Intensity Illuminator. Arrows indicate the critical areas that pass unseen on the ordinary illuminator even though they definitely exist on the film, and can be seen with adequate illumination.

The KELEKET High Intensity Illuminator provides a full 14″x17″ front surface that allows the largest films to be viewed at one glance. With smaller films masking reduces the illuminated front to the desired size. For detailed inspection of *any critical area* the 3″ spot is used, where 4 times the intensity of the large front surface easily illuminates films up to density 4.5.

Illumination on both the 14″x17″ surface and the 3″ spot is controlled by a stepless voltage regulator which selects any degree of intensity desired from zero to the maximum.

For more detailed information write for Catalog F-11.

ARMY E NAVY

KELLEY-KOETT X-RAY MFG. COMPANY
22010 WEST FOURTH ST., COVINGTON, KY.

PIONEER CREATORS OF *QUALITY* X-RAY EQUIPMENT SINCE 1900

Dust-Removing Work Bench

A Multi-Wash ventilated work bench, developed by the *Claude B. Schneible Co.,* 3953 Lawrence Ave., Chicago, removes dust from operations, such as grinding, filing, chipping, buffing, cleaning and polishing of iron, steel, aluminum, magnesium, molded plastic and vitreous parts. Operators are thoroughly protected against dust and fumes.

The bench is available in single and double-side models, and in any one of four arrangements. One model of the double type allowing for workers on either side, has two working surfaces 10 ft. long and 30 in. wide. Either hardwood or steel grating can be furnished.

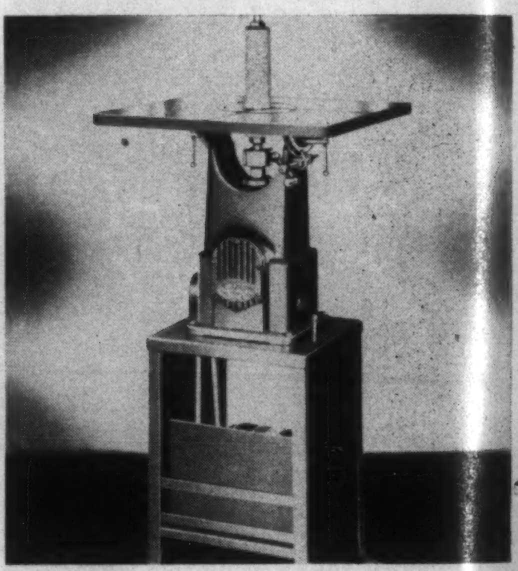
Space under the grate is closed by a dust hopper, sloping to a longitudinal center tank. Air is drawn from the room and over the work by motor-driven fans. Dust particles are impelled against a set wall in the back of the bench, or the wet panel below the grate and washed downward into the tank below.

Dust is also picked up by the indrawn air and carried downward through the grates into the dust chamber, where it is impinged on the wet surfaces. Final removal is done by washing the air in collector units within the bench. The cleansed air is discharged back into the workroom through a safety filter. Solids are also removed efficiently.

● Counterbores are made from broken double-end mills at the *Mansfield (Ohio) Works of Westinghouse.* Usually two counterbores are made from each broken tool. The end mill is first annealed, then cut in half. Each part is then mounted in a lathe and pilot machined. The counterbore is then backed off and rehardened. Reamers and drills can be reclaimed in a like manner.

Oscillating Spindle Sander

A rapid oscillating spindle sander uses a very small diameter abrasive sleeve and provides four sizes from ¾ to 3 in. Made by *Boice-Crane Co.,* 962 Central Ave., Toledo, Ohio, it is portable and vibrationless



and sands any degree of bevel up to 6 in. in height. It will grind aluminum, masonite, brass, die castings and sheet iron for templates. Faces which blend gradually through different slopes at successive cross sections can be sanded.

The sand drum oscillates automatically through a ⅞ in. stroke, 83 complete strokes at 2500 r.p.m. sanding silky smooth with the coarsest, faster-cutting abrasives.

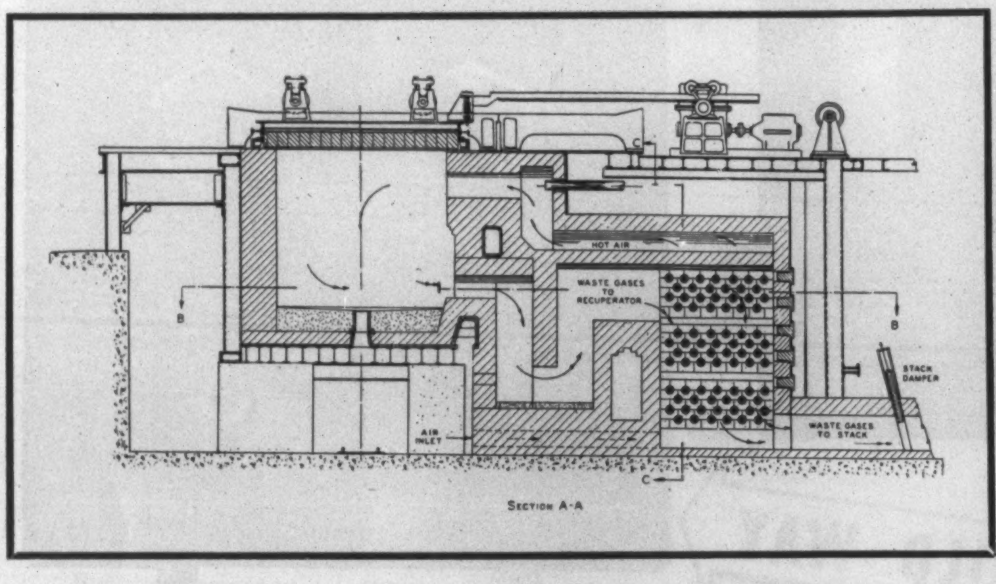
Welder's Shields With Locking Devices

New Huntsmen acetylene and arc welding shields have a patented locking device and a very comfortable, easily adjustable headgear. The locking device holds the shield in the correct position before the face to assure that the line of vision passes through the lens at right angles to the surface of the glass.

It holds the shield firmly above the welder's head while he is preparing his work, with a slight nod of the head lowering the shield into the correct working position. They weigh from 1 to 1½ lbs.

It is sold by *Davis Emergency Equipment Corp.,* 55 Halleck St., Newark, N. J.

"FITCH" RECUPERATORS for SOAKING PITS



SECTION A-A

One of 5 holes rebuilt with our tubular recuperator to replace the recuperators previously used. To date there are over 150 pits of various designs equipped with a "Fitch" Recuperator.

Write for Bulletin No. 12
"Fitch Recuperators for the Steel Industry"

FITCH RECUPERATOR CO.

PLAINFIELD NATIONAL BANK BLDG. PLAINFIELD, NEW JERSEY

8 WAYS TO GET BETTER STEEL CASTINGS Quicker

1 Anticipate your needs. Give your foundry as much time as possible—they are busy, too. It will help them to know what you need and when you will need it.

2 Whenever possible, avoid special alloys and specifications. Standard specifications are quicker to produce and deliver, especially under war conditions.

3 You'll get better castings—quicker—if you don't expect your foundry to cast parts designed for other methods of production.

4 Consult your foundryman on designs. Often he can make contributions that result in better castings—in less time and at lower cost.

5 Consult your foundryman on patterns—or let him make patterns for you. Proper proportioning of casting members, and proper gates and risers always mean sounder castings.

6 Be sure to give your foundry full and complete specifications, particularly when special testing of castings is required.

7 Specify deliveries that meet your actual production schedules. Don't hoard castings—you may be crippling another plant's production.

8 Look upon your foundryman as a part of your own organization. Work with him—in full cooperation—you are both trying to WIN THE WAR.

Steel Founders' Society of America • Cleveland, Ohio

MODERNIZE AND IMPROVE YOUR PRODUCT WITH

STEEL CASTINGS

Replaceable Inserts and Studs

A new application of the Rosan locking system for threaded inserts and studs in metals, plastics, etc. is announced by *Bardwell and McAlister, Inc.,* Box 1310, Hollywood, Calif. This device, Rosan one-piece molded-in insert, and the stud, is for plastics and other molded materials that need fastening points. Like the standard Rosan threaded inserts and studs, it is locked in, but can be removed without injury to the material and replaced by a standard Rosan locked-in threaded insert.

The new molded-in insert not only may be removed, but it leaves a threaded, counterbored and serrated hole into which a standard threaded insert or stud may be screwed and locked by the regular process of the Rosan locking system.

On the insert or stud is a serrated collar. The Rosan locking ring serrated inside and out, engages its inner teeth with serrations on the collar while its outer teeth, or splines, broach their way into the parent material at the sides of the counterbore. Pressure of the surrounding material causes the ring to close in enough upon the collar to eliminate all tolerance and make a solid installation that is permanent.

To remove the molded-in insert for replacement with the standard unit, the serrated locking head at the top of the insert is drilled into the thread relief, this leaving the outer portion of the head in the form of a serrated ring. An "easy out" tool inserted in the drill hole backs out the threaded portion of the insert and the remainder of the ring may be lifted out by hand.

To remove the one-piece molded-in stud, a hollow mill drills out the serrated locking flange of the stud. Threads and serrations are left molded in the material so that standard units may be installed without further operations.

Improved Rockwell Hardness Testers

An improved instrument for Rockwell hardness testing in three models is announced by *Clark Instrument, Inc.,* Dearborn, Mich. Among its many features are: A frictionless spindle, which provides a correct minor load at all times; zero drag trip, which eliminates friction or drag on the loading beam, insuring consistent accuracy of the major load, a dial indicator adjustment, affording a convenient simple means of maintaining accuracy of readings; and a minor load adjustment.

Other interesting features are: Fully enclosed elevating screw with self-lubricating oil reservoir and an adjustable steady rest. There also are steel ball penetrators and a diamond cone penetrator for Rockwell testing on C scale, B scale and most other standard Rockwell scales.

● One of the interesting stories that will be told after the war is how superchargers are made — materials and processes. They must withstand temperatures as extreme as —67 deg. F. and 1500 deg., but only 18 in. distant. The unit operates at 25,000 r.p.m., states Lisle Hodell, superintendent of the new G. E. plant at Fort Wayne, Ind., which makes superchargers.

Selenium Rectifier Stacks

Selenium rectifier stacks have been added to the Tungar and copper oxide rectifier line by *General Electric Co.,* Schenectady, N. Y. Better forward current characteristics and extremely low leakage, through a new and patented manufacturing process, are responsible for higher operating efficiencies between the a.c. input and d.c. output.

By connecting stacks in parallel, higher current output results, and by connecting in series, higher voltage ratings. They are lighter in weight and smaller in overall size than any other type of metallic rectifier.

They can be bolt or stud mounted directly to equipment assemblies, and are also available with mounting brackets for convenient assembly to panels.

ONE
HYDRO-WHIRL
COLLECTS DUST
FROM
EIGHTY
SEPARATE
MACHINES

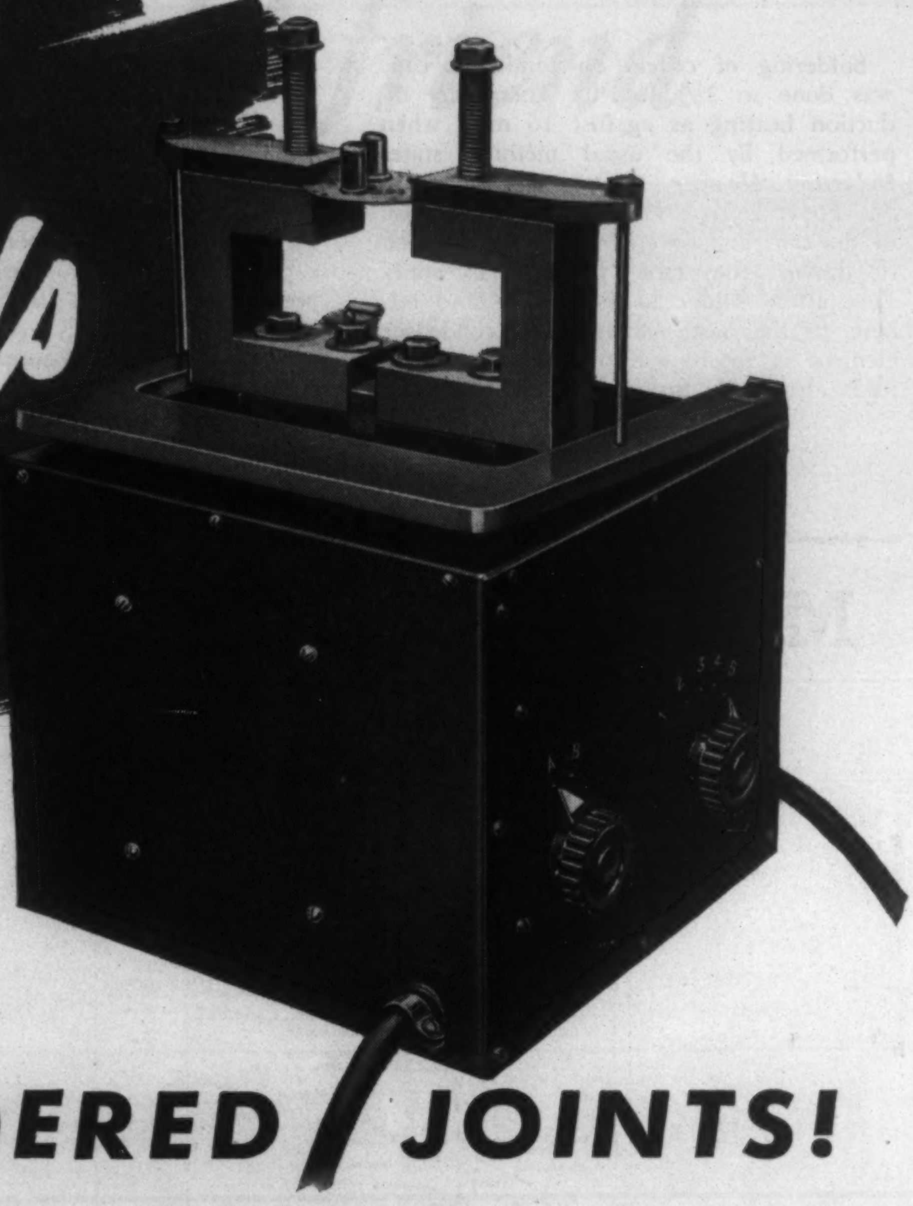
Hydro-Whirl Dust Collectors are engineered to meet any requirements—from 700 to 100,000 C.F.M.—designed for all forms of metal dust (magnesium, aluminum, iron) created from grinding, buffing, polishing, or sanding. The dust is "water-whirled" out of the air and is knocked down into a tank below, from which it is removed periodically as sludge by conveyor.

BUY WAR BONDS

HYDRO-WHIRL

INDUSTRIAL SHEET METAL WORKS
NEW NAME → PETERS-DALTON, INC.
608 EAST FOREST AVE., DETROIT 1, MICH.

MFRS. HYDRO-WHIRL DUST COLLECTORS AND SPRAY BOOTHS — INDUSTRIAL OVENS, MECHANICAL WASHERS AND VENTILATION SYSTEMS



1 to 2 Seconds

FOR MANY

SILVER-SOLDERED JOINTS!

This **a.c.f.** Berwick Soldering Transformer makes *speedy* and *secure* soldered joints. Joints that meet the exacting war requirements for strong, husky work that can meet rough usage.

Widely used for soldering radio parts, cords, telephones, and for other Army and Navy spot heating. Available in 43 different sizes, for *resistance* as well as *induction* heating.

Write us. State your problems, or send samples, and we will try to show you how you will benefit by using the correct type of **a.c.f.** Soldering Transformer for whatever type solder you use.

In addition to the **a.c.f.** Berwick Soldering Transformer, **a.c.f.** Berwick Electric Metal Heaters are available in a wide variety of models, designed to heat anything from a rivet to a 30-foot bar.

AMERICAN CAR AND FOUNDRY COMPANY

30 Church Street, New York, N. Y.

CHICAGO • DETROIT • ST. LOUIS

Soldering by Induction Heating

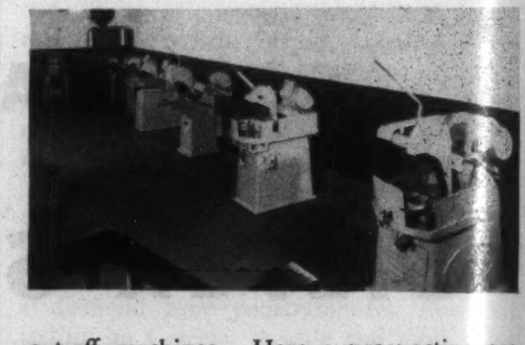
Soldering of covers on condenser cans was done in 2½ sec. by Thermonic induction heating as against 16 min. when performed by the usual method, states *Induction Heating Corp.*, 389 Lafayette St., New York. Preliminary preparation of the cans and covers, which are stamped or drawn from terne plate, is to apply flux, allow solder to run freely and adhere to the base metal. The condenser element is inserted into the can and its leads electrically fastened to the terminals, brought through the cover of the can.

Assembled cans are placed in an 8-can fixture. A ring of solder, having the same shape as the periphery of the joint, is preplaced over the section to be joined. The 8-can assembly is raised to bring the joint area in proper relation to the copper work coil. The start button is pressed and heat is immediately evolved in the joint section. A timer shuts off power in 2½ sec. Where large production is required, a 2-position coil set-up is used. This transformer operates at a terminal voltage across the coil of about 200 volts and allows the coil to be grounded for safety.

● A new synthetic plastic reinforced with glass is used in certain U. S. war planes. Glass cloth woven from yarns manufactured by *Owens-Corning Fiberglas Corp.*, Nicholas Tower, Toledo, Ohio, serves as reinforcement. Previous so-called self-sealing gasoline tanks sometimes failed. When a bullet punctured the metal surrounding the tank the metal would "flower", and jagged petals of the flower protruded into the self-sealing material so it could not close the hole. The plastic and glass did not flower, the bullet making a clean hole, with nothing to prevent the self-sealing material from closing it.

Cut-Off Laboratory

A large cut-off laboratory has been established at 106 S. 16th St. at Chestnut St., Philadelphia, equipped with seven types of Radiac grinding wheels and abrasive cut-off machines. Here a prospective customer may bring samples of work to be done. Specimen cuts are made and the engineer in charge recommends the proper grain and grade combination of the abrasive disc for the job.



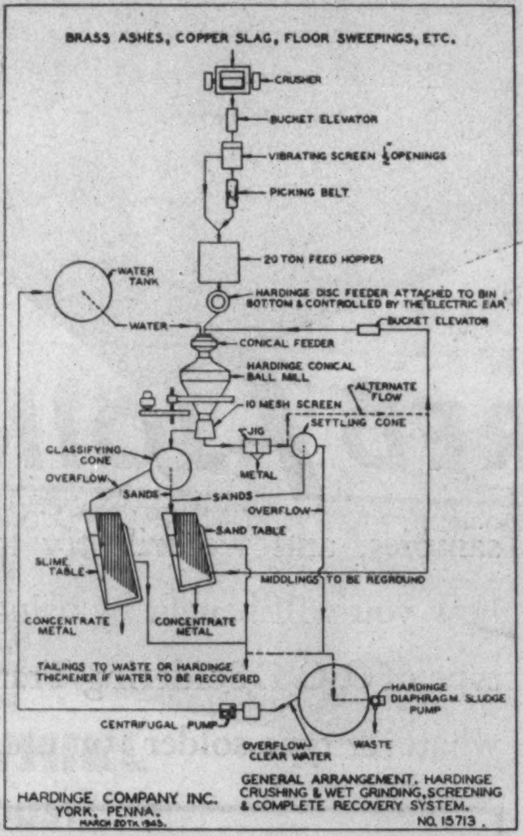
Many important and successful cutting tests in various alloyed steels have been conducted in the laboratory, which is run by *A. P. de Sanno & Son*, Phoenixville, Pa.

Oil Treating, Filtering, Reconditioning Machine

A complete oil treating, filtering and reconditioning machine for cutting, grinding and honing oils that should be heated before filtering has been developed by *Sparkler Mfg. Co.*, 319 Lake St., Mundelein, Ill. Many of these oils must be filtered very sharply to remove microscopic metal particles, germs and other impurities. Yet they must be heated so as not to filter out certain additives such as sulphur, lard, wax, etc.

The equipment consists of a 100-gal. mixing and heating tank, equipped with electric immersion heaters, a mechanical agitator, thermometer, a filter aid storage box, a main line fused knife switch, a magnetic push-button controller, an 18-D-12 horizontal plate 600 gal. per hr. filter, a rotary pressure pump and 1 h.p. motor. The tank will heat 100 gal of oil from 80 to 180 deg. F. in 30 min.

METAL RECLAMATION


BRASS ASHES, COPPER SLAG, FLOOR SWEEPINGS, ETC.
CRUSHER
BUCKET ELEVATOR
VIBRATING SCREEN ½" OPENINGS
PICKING BELT
20 TON FEED HOPPER
WATER TANK
HARDINGE DISC FEEDER ATTACHED TO BIN BOTTOM & CONTROLLED BY THE "ELECTRIC EAR"
WATER
BUCKET ELEVATOR
CONICAL FEEDER
HARDINGE CONICAL BALL MILL
ALTERNATE FLOW
10 MESH SCREEN
SETTLING CONE
JIG
CLASSIFYING CONE
METAL
OVERFLOW
SANDS
SANDS
OVERFLOW
SAND TABLE
SLIME TABLE
MIDDLINGS TO BE REGROUND
CONCENTRATE METAL
CONCENTRATE METAL
TAILINGS TO WASTE OR HARDINGE THICKENER IF WATER TO BE RECOVERED
HARDINGE DIAPHRAGM SLUDGE PUMP
CENTRIFUGAL PUMP
OVERFLOW CLEAR WATER
WASTE
HARDINGE COMPANY INC.
YORK, PENNA.
MARCH 20TH 1943.
GENERAL ARRANGEMENT. HARDINGE CRUSHING & WET GRINDING, SCREENING & COMPLETE RECOVERY SYSTEM.
NO. 15713 .

For the recovery of metal from brass ashes, slag and floor sweepings

A complete treatment large capacity plant
Recovers all of the metal
Clarifies and recirculates treatment water

If you are interested in a complete recovery of the metal, write for information.

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COMPANY, INCORPORATED - YORK, PENNSYLVANIA
NEW YORK, CHICAGO, SAN FRANCISCO, TORONTO

CONICAL MILLS | COUNTER CURRENT CLASSIFIERS | THICKENERS CLARIFIERS | RUGGLES-COLES DRYERS | CONSTANT WEIGHT FEEDERS | TUBE ROD AND BATCH MILLS

Fighter, *and friend*

Here's the stock fighting tool of American soldiers and marines—a Garand rifle equipped with a bayonet.

Bethlehem Steel Company has produced hundreds of tons of ⅞-inch square bars from which bayonets are forged and machined. In addition, we are producing alloy-steel bars from which the Garand barrels are made. Finally, this company's continuous mills are turning out tremendous tonnages of bullet-core wire—the wire which is used in forming the slugs which spit from the muzzle of the Garand. These items, and countless other kinds and shapes of steel for our fighting men are being shipped from Bethlehem plants in ever-mounting volume.

★ ★ ★ BETHLEHEM STEEL ★ ★ ★

TWISTERS, BENDERS, and BIMORPHS

for War . . and the Peace to come

The keynote to Victory is Teamwork. The Allies have it in battle and production. Twisters, Benders, and Bimorphs form a team as a part of The Brush Surface Analyzer that measures the smoothness of finished surfaces. This tiny team can do the work of an army of men.

Today Brush Crystals are doing wartime service, but in the peace to come these same crystals (Twisters, Benders, and Bimorphs) will serve people everywhere in untold ways.

Thus, The Brush Development Company works today, for the better things tomorrow.

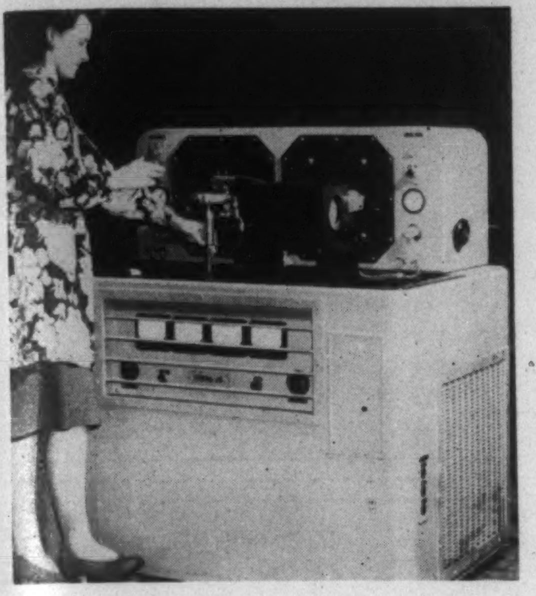
THE BRUSH DEVELOPMENT COMPANY

3311 Perkins Avenue Cleveland, Ohio

BRUSH
CRYSTAL
PRODUCTS

New Model Light Induction Heater

A new, highly flexible 15 kw. output Tocco Junior induction heating machine is announced by the *Ohio Crankshaft Co.*, Cleveland 1, the seventh of the Junior models. It can be adapted to brazing, annealing, heat treating, heating for forging and surface hardening of small and medium parts. Trained electrical engineers are not necessary for normal operations. It is priced within reach of the smaller manufacturer and is a handy utility machine for large operators.



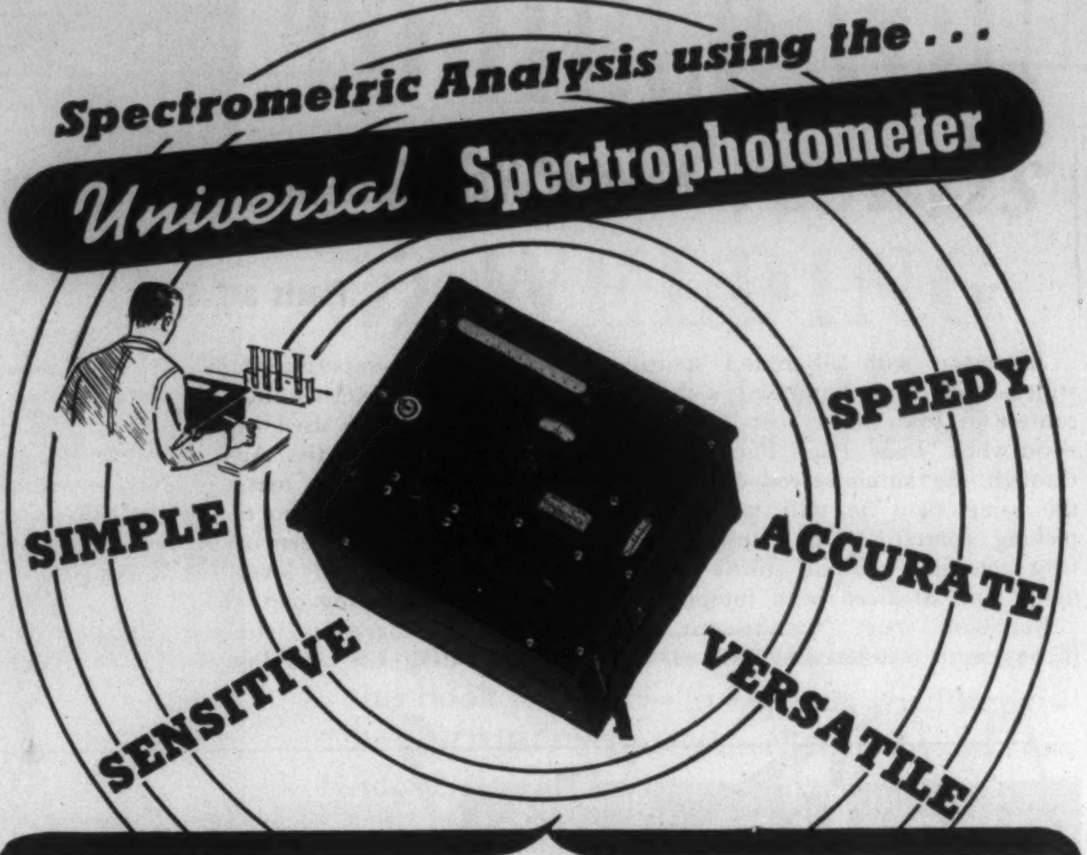
A 20 h.p. motor generator insures dependable power that maintains accuracy of heat control always. It is especially good for brazing of small parts such as carbide tips; also tube fittings, shell adapters, burster tubes, etc. It offers preset automatic controls, quenching auxiliaries, transformers, capacitors, fool-proof meters and push-button starting and stopping.

● A smaller unit has been added to the line of office-type dust collectors brought out by *Industrial Equipment Corp.*, 625 E. Forest Ave., Detroit. It has a volume capacity of 1200 c.f.m., is designed especially for the double-spindle grinding and buffing lathes, and is good with magnesium.

Continuous Drum-Type Pickling Machine

A continuous drum-type pickling machine for high-speed cleaning of shell cases has been developed by the *Howard Engineering & Mfg. Co.*, 1836 Freeman Ave., Cincinnati. It can pickle 8,000 37-mm. cases per hr. Parts to be cleaned travel through the machine in a drum which varies in diameter between sections so that each section of the drum runs in its particular tank. Scale is removed from annealed parts by successive pickling, rinsing, neutralizing and rinsing.

The machine operates without use of pumps. Acid, rinse and neutralizing solutions are picked up by scoops on the side of the drum and dumped on the parts. Pickling and first rinse drums are of Monel metal and the tanks are lead-lined. It can be adapted to pickling of parts other than shell cases.



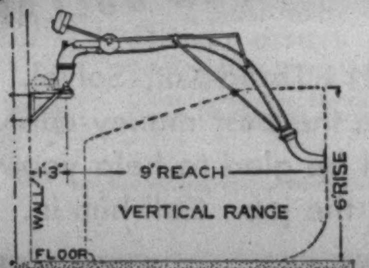
Spectrometric Analysis using the . . .
Universal Spectrophotometer

COPPER, NICKEL AND MOLYBDENUM DETERMINATIONS IN 20 MIN.

Test tubes for samples and instantaneous readings fit the Coleman Spectrophotometer into the high speed tempo of modern steel laboratories. Write today for Bulletin MA943, mentioning best priority available.

WILKENS-ANDERSON CO.
111 NORTH CANAL STREET • CHICAGO, ILLINOIS

CLEAR YOUR PLANT OF
WELDING FUMES!



GUARD EMPLOYEE HEALTH by installing Ruemelin Fume Collectors wherever welding operations take place. They remove noxious gases, heat and smoke at the source . . . eliminate employee fatigue . . . speed up welding operations. Built in 3 foot, 9 foot and 15 foot sizes. Hundreds in operation all over the country. Write for bulletin No. 37-C.

Ruemelin Mfg. Co., 3894 N. Palmer St., Milwaukee 12, Wis.

RUEMELIN FUME COLLECTOR

News of Men, Societies, Meetings and Companies

Plants and Slants

A person with all-around sporting instincts will have witnessed a hog-calling contest in Iowa on a crisp October afternoon when "Puey, Puey, Puey" reverberates through the autumn-treed hills, while in the same state he will take in a corn-picking contest. Our "sport" has seen frog jumping contests, turtle races, bull fights, and Mexican bean jumping rodeos.

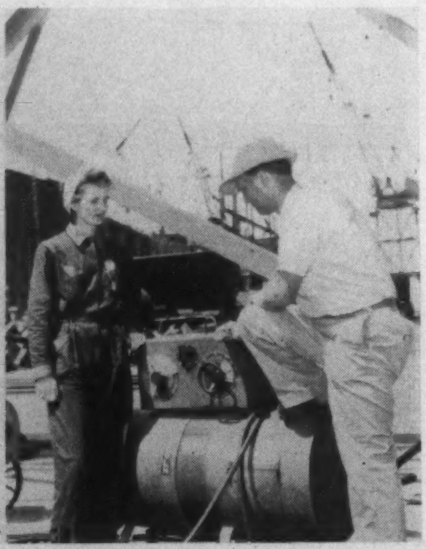
But our "sport" hasn't seen anything if he hasn't witnessed a women welders' contest. Such is depicted here — the first National Women's Arc Welding Championship (no holes barred) at the *Ingalls Shipyard*, Pascagoula, Miss. In a roped-off ring, the girls did flat, vertical and overhead welding tests, "seconded" by veteran Ingalls welders.

In the photo at the left are Miss Vera Anderson of Ingalls and Mrs. Hermina Strmiska of *Kaiser's Oregon Shipbuilding Co.*, in Portland. Here they are starting the vertical test in Round 2. At the right is the win-nah, Miss Anderson, with her welding superintendent, W. B. Bowen, resting between rounds on one of the welding machines used in the contest.

Blue-eyed Miss Anderson received $350 in war bonds, a massive silver loving cup, a week-end trip to the White House, and the title of "queen of the welding world." How long will lovely Miss Anderson retain her loving cup?

(Photographs, courtesy Ingalls Shipbuilding Co. and Lincoln Electric Co.)

FIRST
WOMENS NAT
WELDING CHAMP
ONSOR INGALLS



Usually when a company employee makes an invention in his line of work, the company reaps all the benefits, perhaps giving a small bonus. However, the *Glenn L. Martin Co.* has set up an Employees' Patent Remuneration Plan, under which the employee is given an equitable share of the income from the patent. Seven Martin inventors have already benefited, though the plan has prevailed for only a short time. The employee-inventor receives a share of the proceeds from licensing, starting at 10 per cent, until he has received $5,000, and according to a sliding scale thereafter.

As stated in these columns before, many company booklets commemorating receipt of Army-Navy "E"s, follow a conventional pattern. Occasionally they vary in a refreshing manner. Thus the booklet of the *Carborundum Co.*, Niagara Falls, N. Y., explains the background of the "E" idea. Nominations for the award are originated by the procurement officers for the Army, and the local inspector or supervisor for the Navy in the district where the plant is located. Nominations are forwarded to Washington. Final selection is made by Gen. William S. Knudsen, Director of Production, chairman; Maj. Gen. Charles M. Wesson, former Chief of Ordnance; Brig. Gen. Bennet E. Meyers, Executive Officer, Material Command, Air Forces; Hon. Edward F. McGrady, special consultant to the Secretary of War; A. R. Glancy, chief of production branch, Procurement and Distribution Division, Services of Supply; and J. E. Harrell, Civilian Personnel Division, Services of Supply, recorder.

American Brake Shoe Co. has bought the *Electro-Alloys Co.*, Elyria, Ohio, and will operate it as a subsidiary.

McKenna Metals Co., Latrobe, Pa., has been succeeded by *Kennametal, Inc.* The company makes steel-cutting cemented carbide.

The iron ore carrier, *Clarence B. Randall*, named for the vice-president of *Inland Steel Co.*, has completed her maiden trip with a 15,000-ton cargo from the Marquette range in Michigan. The vessel is owned by the *Pioneer Steamship Co.*, Cleveland.

THE COST OF CUTTING FLUIDS IS MEASURED IN PENNIES
...TOOLS AND PRODUCTION IN DOLLARS...

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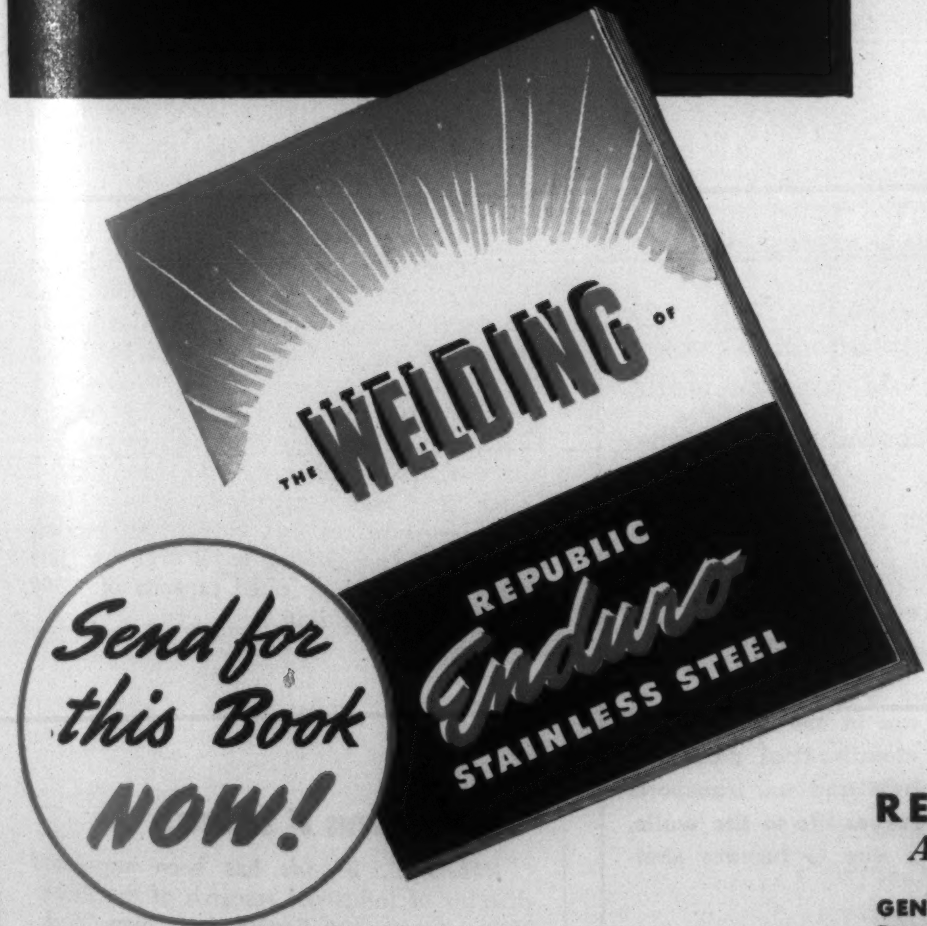
Republic metallurgists and engineers prepared this book for YOU—to help you weld Republic ENDURO Stainless Steel soundly and economically on a steady production basis.

It contains twenty pages of useful information based on Republic's many years of pioneering stainless steel and wide experience in the production and fabrication of this metal. It covers electric arc, spot, projection, atomic hydrogen, gas, flash and seam welding.

It discusses the various analyses, their relative welding qualities and precautions to exercise. It contains diagrams of joint set-ups. It includes brazing and silver soldering. And it contains a two-page chart showing physical, electrical, mechanical, heat-treating, heat-resisting, machining and drawing or stamping properties of the popular analyses.

This book has proved a very useful and valuable aid to thousands of users of stainless steel—and will do the same for you. Write us for a copy—and, if you are interested in other methods of fabrication (stamping, drawing, machining, forming, etc.), ask also for a copy of "The Fabrication of Republic ENDURO Stainless Steel". Either or both books will be sent promptly.



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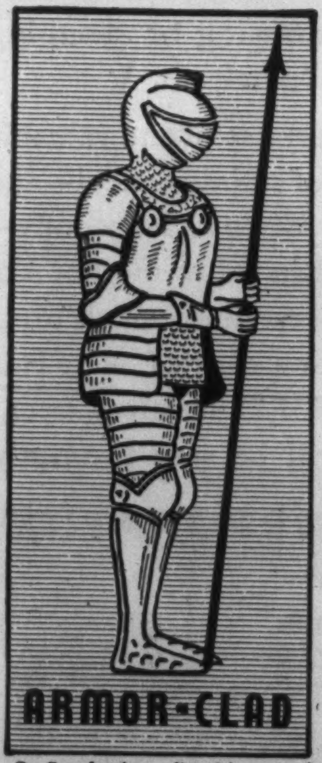

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Armor-Clad heat setting furnace wall coating provides an amazingly effective protective coating to new and old furnace walls.

Armor-Clad coatings prevent slag adhesions, flame penetration, spalling, acid or basic attack, and cold air infiltration.

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Armor-Clad protective coatings are in use in many nationally known industrial and metallurgical plants, in government arsenals, in the navy and on transports and on ships at sea, providing longer life to fire walls, reducing interruptions of service due to furnace shutdowns.

Because of their unusual protective qualities, ease of application, and the splendid service rendered, Armor-Clad refractory coatings are being adopted by operating engineers who recognize their advantages over all other forms of refractory wall protection.

ARMOR-CLAD COMPANY
EMIL A. SCHROTH, PRESIDENT
39 Hyatt Avenue Newark, N. J.

Because the United States is a modern country, real history is rare. However, interesting historical memories entered a broadcast from *Lukens Steel Co.*, Coatesville, Pa. on the series "This Nation at War," sponsored by the National Association of Manufacturers and designed to tell how communities contribute to the war effort. The broadcast was made from the chemical laboratory on the site of the original mill where boiler plate was first rolled in America. The company was founded by Quakers, Isaac Pennock and Jesse Kersey, along the famous Brandywine Creek. For a time the company developed under the leadership of Pennock's daughter, Rebecca Lukens. On the program was Austin Gilbert, whose ancestors have been with the company since 1830.

The *Tulsa Chemical Co.*, Tulsa, Okla., was incorporated July 1 to make anhydrous hydrofluoric acid. Interest in the company is divided among the *Pennsylvania Salt Mfg. Co.*, Philadelphia, the *Mahoning Mining Co.*, Rosiclare, Ill., and *Ozark Chemical Co.*, Tulsa.

George R. Mowat Co., protective coatings, is now located at new quarters at 24-26 W. 40th St., New York 18.

B. D. Saklatwalla, metallurgical consultant, has moved offices to 1102 Park Bldg., Fifth Ave. and Smithfield St., Pittsburgh.

A sixth electric furnace has started production at the *South Chicago Works, Carnegie-Illinois Steel Corp.* The new furnace has an annual capacity of 65,000 tons. The *South Chicago Works* made its first electric steel in 1909.

The *Ohio Crankshaft Co.*, Cleveland 1, has just appointed five nationally-known machine tool dealers as special sales agents in the following five cities: Cleveland, Syracuse, Pittsburgh, Cincinnati and St. Louis.

Towering above the site of one of the early round top furnaces which helped Andrew Carnegie make steel history in Braddock years ago, one of the world's largest blast furnaces was blown into production at *Edgar Thomson Works* on July 20. It has a daily rated capacity of 1,300 net tons of pig iron.

News of Engineers

Robert C. Woods has been appointed director of industrial research of the Picker X-Ray Corp., 300 Fourth Ave., New York. Previously he was director of research at the Taylor-Winfield Corp., Warren, Ohio, and formerly physicist at the Bell Aircraft Corp., Buffalo. For several years he has been a member of the E-7 committee of A.S.T.M., a member of the American Physical Society and fellow of the American Association for the Advancement of Science.

Harvey McKenney, who has spent all

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FIREPOWER
BIGGER
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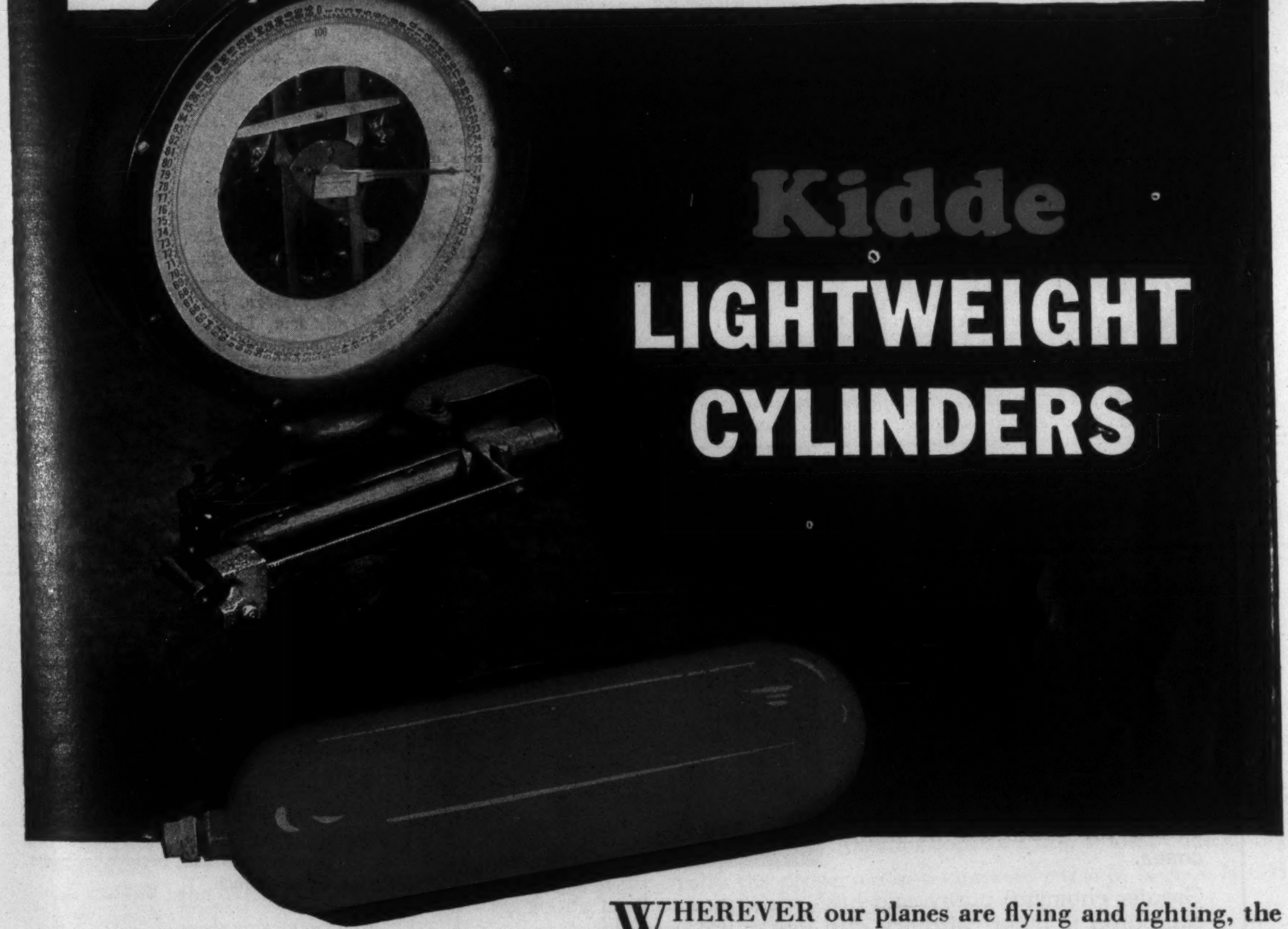

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WHEREVER our planes are flying and fighting, the call is for *less* dead weight...more ammunition, gas, cargo capacity. So Kidde engineers have developed extra lightweight cylinders strong enough to contain the high-pressure gases used in aviation. They're built of special steels, specially treated. Then they're put through stiff hydraulic tests for pressure-resistance, micrometer-checked for uniform wall thickness.

Kidde containers cover a wide range of sizes and shapes, are fitted with valves or release mechanisms designed for many purposes.

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Standardized Ingot

A copper-silicon-zinc alloy of the useful and versatile "Tombasil" family has been developed expressly for the war trend in nonferrous castings.

Its use releases relatively large quantities of tin used in bronze alloys formerly required for such castings.

According to exhaustive laboratory and field reports, this new alloy, known as Ajax "Navy" Tombasil, possesses physical properties far in excess of either Govt. "G" Bronze (88-10-2 and 88-8-4), Spec. 46M6G; or "M" Metal, Spec. 46B8G; as well as the Cu. Si. Alloy known as Spec. 46B28. Your inquiries will receive prompt attention.

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AJAX ELECTRIC COMPANY, INC., *Electric Salt Bath Furnaces*
AJAX ENGINEERING CORP., *Aluminum Melting Induction Furnaces*

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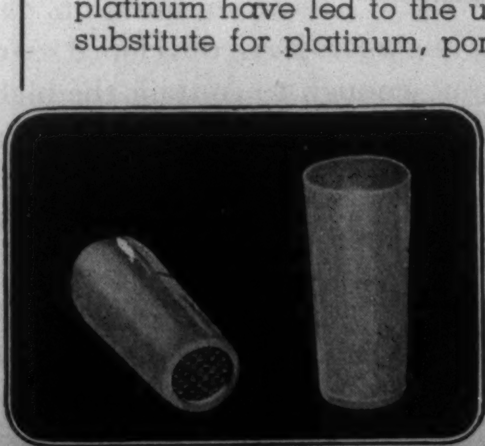
. . . A superior ceramic replacement for porcelain and glass and a satisfactory substitute for platinum in many cases.



Greater chemical purity and high resistance to heat shock as compared to other ceramics and low initial cost compared to platinum have led to the universal adoption of Vitreosil as a substitute for platinum, porcelain and other critical materials in many analytical and research procedures.

Standard items of Vitreosil Laboratory Ware include glazed and unglazed crucibles, combustion boats, evaporating dishes, muffle trays, beakers, trays, tubing and fittings for complete entrainments.

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THE THERMAL SYNDICATE, LTD.
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of his business career in the alloy field, both in production and procurement, has become manager of alloy steel sales of Follansbee Steel Corp., Follansbee, W. Va. He has been with both Carnegie-Illinois and Crucible Steel companies. More recently he was with WPB in the alloy section, iron and steel branch.

Dewey C. Harvey has been promoted to chief plant engineer, Osborn Mfg. Co., Cleveland. Prior to joining Osborn in 1935, he served in the engineering departments of Peerless Motor Co., C. O. Bartlett & Snow Co. and Bender Body Co.

William B. Corbett has been appointed plant engineer and *George Bluth*, general chief inspector, of Willys-Overland Motors, Inc., Toledo, Ohio. Mr. Corbett previously served with Ford, Hupmobile and Chrysler. Mr. Bluth was with General Motors.

William B. Griese, formerly plant manager, Liquid Cooled Engine Div., Toledo, Ohio, has been transferred to plant manager, Spencer Heater Div., Aviation Corp., Williamsport, Pa. He was previously with Crosley Corp. and Lycoming Div.

C. L. Huston, Jr., formerly assistant to the president, Lukens Steel Co., has been named president of Lukenweld, Inc. He has served ten years with American Rolling Mill Co., Middletown, Ohio, half the time in the metallurgical department, and half in public relations.

James E. Kearney has been made chief engineer of the Swenson Evaporator Co., div. of Whiting Corp., Harvey, Ill. Until recently he was with H. K. Ferguson Co. as chemical engineer in charge of the Basic Magnesium project at Las Vegas, Nev., the largest in the world.

A. A. Hassan, Jr., formerly chief metallurgist, Atha Works, Crucible Steel Co., Harrison, N. J., is now divisional superintendent. *Clarence G. Merritt* is promoted to chief metallurgist of Atha Works.

John Easton has been appointed director of development and standardization of Whiting Corp., Harvey, Ill., succeeding *A. J. Brown*, who has become manager, Pacific Coast Branch.

S. R. Kallenbaugh has been named West Coast district manager, Steel and Tube Div., Timken Roller Bearing Co., Canton, Ohio, with offices in Los Angeles. He took post-graduate training in metallurgy at Ohio State University and until recently was metallurgical service representative for Timken at Cleveland and Detroit.

Harry K. Beebe has joined Wales-Strippit Corp., punching and notching equipment, as works manager. Previously he was chief plant engineer for Brewster Aeronautical Corp. and before that plant development engineer with Bell Aircraft Corp.

Dr. John J. Gorrell has joined the metallurgical and engineering service staff of Meehanite Metal Corp., Pershing Bldg., New Rochelle, N. Y. Previously he was

The sun never sets on the fighting jeep . . .

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ITS INHERENTLY FINER GRAIN MAKES ALL THE DIFFERENCE
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Battle-proved on a score of fighting fronts, the Willys-built Jeep has earned a world-wide reputation for ruggedness, for built-in stamina, and for ability to take punishment under all sorts of conditions as to both temperature and terrain.

N-A-X HIGH TENSILE Steel is used in the construction of the Willys-built Jeep, and the unusual qualities of this steel find expression in the field performance of this most versatile of all combat vehicles.

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Write today for your copy of a new booklet describing fully the properties and characteristics of N-A-X HIGH TENSILE and the N-A-X 9100 Series Alloy Steel.

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OFHC Copper is characterized by its freedom from casting defects and its bar-for-bar uniformity. Its freedom from oxygen results in great ductility and toughness as evidenced by its high reduction of area and resistance to impact. OFHC Copper withstands more working in hard condition when tensile strength is greatest, making it especially suited for products subjected to severe fabricating or service conditions.

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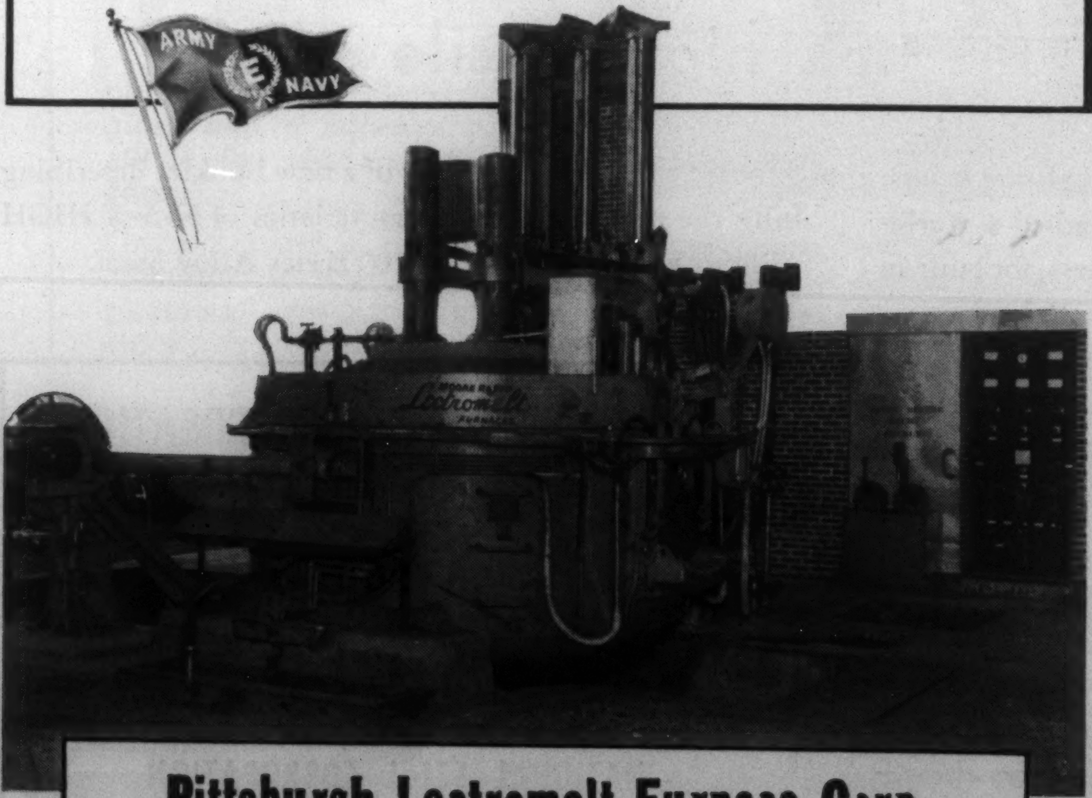
STEEL, the backbone of war production is produced more rapidly and efficiently by Moore Rapid Lectromelt top charge furnaces.



Pittsburgh Lectromelt Furnace Corp.
PITTSBURGH, PENNSYLVANIA

chief chemist of Pressed Steel Car Co., and had been metallurgist for Standard Steel Car Co.

Dr. Robert I. Jaffee, research metallurgist, has joined the technical staff, Battelle Memorial Institute, Columbus, Ohio, where he will do research in non-ferrous metallurgy. Previously he was with Leeds & Northrup Co., Philadelphia.

John H. Staiger has joined the metallurgical staff of Michiana Products Corp., Michigan City, Ind., maker of heat and corrosion-resistant alloy castings, etc. Until recently he was metallurgical engineer with La Salle Steel Co., Hammond, Ind.

John Robert Doig, Jr., physicist, has been appointed to the research staff of Battelle Memorial Institute, Columbus, Ohio, and assigned to its division of physics. He has a master of science degree from Pennsylvania State College, where he majored in physics and metallurgy and served as graduate assistant for four years

Robert W. O'Neal has joined Follansbee Steel Corp., Follansbee, W. Va., as industrial engineer in charge of methods and standards. He has done similar work with Carnegie-Illinois Steel Corp.

Walker Penfield, formerly manager of engineering, has been appointed works manager of the Pennsylvania Salt Mfg. Co., Philadelphia. *William F. Mitchell* is now assistant to the works manager. *Floyd H. Walker* is appointed chief engineer. *A. E. Gaydos* becomes assistant to the vice-president in charge of manufacturing.

Russell B. Gunia has been appointed manager, Stainless Steel Bureau, Metallurgical Div., Carnegie-Illinois Steel Corp., succeeding *Elmer Gammeter,* who left the corporation. In March, 1938 he became employed as a junior metallurgist at the Gary sheet and tin mills. Since 1940 he has been with the Stainless Steel Bureau in Chicago.

J. W. Peckham has been made manager of the development and design engineering department, Bristol Co., Waterbury, Conn., maker of automatic control and recording instruments. He has been in the radio research department, General Electric Co.

L. J. Rohl has been made manager of the Chicago district metallurgical department of Carnegie-Illinois Steel Corp. He succeeds *R. K. Bowden,* who has gone to Pittsburgh as director of quality control, research and technology department.

Buford M. Stubblefield has been made superintendent of the Brier Hill Works, Youngstown Sheet & Tube Co.

Dave M. Whyte has been appointed supervisor of casting sales of Cooper-Bessemer Corp.'s two foundries. He has made valuable contributions to new foundry methods and techniques.

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Steel Shell Cases and Ordnance Parts Should be Deoxidized with Deoxidine

The safe, effective, economical way to prepare steel shell cases, shells and other steel ordnance parts for the protective finish.

The substitution of steel shell cases for brass is one of the major accomplishments of American ingenuity in the present war. Details of drawing, annealing, finishing, etc., have been successfully worked out in plants and Government Arsenals where these problems were not entirely new.

The need for unusual protection of the finished shell case against rust in overseas shipment and use under severe climatic conditions, however, presents a new and serious problem to many manufacturers.

The best finishes available fail under severe exposure conditions if the surface on which they are applied is not clean chemically as well as mechanically, free from invisible rusters as well as visible rust. The DEOXIDINE process is admirably suited to the proper preparation of the metal to receive and hold a durable protective finish so necessary for "successful missions." The often overlooked, though important detail of proper rinsing in slightly acid solutions is accomplished with DEOXYLYTE as a part of the DEOXIDINE process.

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The success of the steel shell case and all other ordnance parts in combat will depend upon close adherence to such seemingly unimportant details.

DEOXIDINE meets U. S. Ordnance Department requirements in removing rust and neutralizing rust producers before protective finishes are applied.

ACP will help in guiding you in the proper preparation of steel shell cases, shells and any other ordnance parts to receive the specification finish. Descriptive literature will be sent on request.

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American Chemical Paint Company, Ambler, Pa.
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INVESTIGATE SCAIFLUX 21

Providing many practical advantages that speed and simplify brazing practice and bring better results, Scaiflux 21 is the answer to many vexing brazing problems. It has been amply tested in production work, and found admirably suited for industrial use.

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SCAIFE COMPANY
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Briefs on Associations, Promotions, Education

One of the best rounded programs to keep workers satisfied is that of the *Fischer & Porter Co.*, Hatboro, Pa. — a 12-point program as follows: Most liberal vacations in the Philadelphia area, unemployment and retirement fund which has risen to over $40,000 in one year, hospitalization plan, salary continuation plan for time lost during disability, rest periods morning and afternoon with free refreshments, farm-supplied modern cafeteria at minimum prices, credit union sponsored by the company, Rota-Review published for employees, music while they work, 3 per cent bonus for perfect attendance, complete first aid rooms and free legal advice.

The *Gray Iron Founders' Society*, Cleveland, has created a new post of educational director, which will be filled by John P. Mullen. He has been in advertising, publicity and promotional work for 20 years. He will be at the Washington, D. C. office of the Society.

Training in physical metallurgy for men and women employed in metal and associated industries started at Columbia University September 13, in cooperation with the U. S. Office of Education. It is a course for those who have an educational background and are beginners in metallurgy. Prof. George L. Kehl will direct the studies. Instruction will cover states of aggregation, detailed study of binary and ternary alloy systems, plastic deformation of single crystals and polycrystalline metal; recrystallization and grain growth; metallography of important aluminum, copper, and other non-ferrous alloys; the constitution of plain carbon steels, alloyed steels and cast iron, and the principles of heat treating steel.

The third War Production Foundry Congress of the *American Foundrymen's Association* will be held at Buffalo the week of April 25, 1944. Provision will be made for suppliers of equipment and materials to demonstrate the utility of their products in war production and conservation of materials. Annual meetings of foundrymen have been held in Buffalo twice previously, once in 1912 with an exhibit and once in 1901 without an exhibit. R. E. Kennedy has become the administrative head of A.F.A., filling the vacancy created by the resignation of C. E. Westover as executive vice-president. The office of executive vice-president and secretary have been combined.

A meeting of electric furnace steel executives and technicians will be held at Hotel William Penn, Pittsburgh, Oct. 1 and 2, under the auspices of the Iron and Steel Div., American Institute of Mining and Metallurgical Engineers. A separate Proceedings will be published of the meetings, containing electric steel problems and solutions discussed.

Deaf-mute workers producing portable emergency landing mats at the Oakland, Calif. plant of the *Irving Subway Grating Co.* are 25 to 35 per cent more efficient than average workers not so handicapped, states J. C. Lynn, Western div. manager. Their facile hands are better coordinated. Moreover no deaf mute has had an accident.

Spoiled work at the York St. plant, *Republic Aircraft Products Div., Aviatio Corp.*, Detroit, is displayed prominently on a table for all employees to see and is looked over every two or three days by department managers and superintendents. Behind the table is a large cartoon showing the Axis offering congratulations for the spoilage. Some of the highly finished products can be ruined by a scratch or mar, hence the company takes unusual steps to wrap and protect the work in process.

Meetings and Expositions

SOCIETY OF AUTOMOTIVE ENGINEERS, national tractor meeting. Milwaukee, Wis. September 23-24, 1943.

ASSOCIATION OF IRON AND STEEL ENGINEERS, annual meeting. Pittsburgh, Pa. September 28-30, 1943.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS and the ENGINEERING SOCIETY OF CANADA, joint meeting. Toronto, Canad. September 30-October 1, 1943.

SOCIETY OF AUTOMOTIVE ENGINEERS, national aircraft engineering and production meeting. Los Angeles, Calif. September 30-October 2, 1943.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, Iron and Steel Division, Electric Furnace Steel Committee, 1st annual conference. Pittsburgh, Pa. October 1-2, 1943.

ELECTROCHEMICAL SOCIETY, annual convention. New York, N. Y. October 13-16, 1943.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Regional meeting: Inst. of Metals and Iron & Steel Divisions. Chicago, Ill. October 16-19, 1943.

AMERICAN SOCIETY FOR METALS, annual convention. Chicago, Ill. October 18-22, 1943.

AMERICAN WELDING SOCIETY, annual meeting. Chicago, Ill. October 18-22, 1943.

WIRE ASSOCIATION, annual convention, Chicago, Ill. October 18-22, 1943.

O W I Photo by Palmer, in an Allegheny Ludlum Plant

Final Examination

BEFORE STAINLESS GETS ITS WINGS

REDUCE ACCIDENTS!

In 1941, accidents were first cause of death among men from 22 to 38 years of age. The productive man-days lost were enough to build twice as many battleships as now possessed by the combined Allied Navies. These are losses that *can* be avoided. Warn your employees repeatedly not to take risks on or off the job—cooperate in every way possible with the National Safety Council's *War Production Fund to Conserve Manpower,* William A. Irvin, National Chairman, Chrysler Building, New York City.

A GREAT DEAL of costly processing is done on stainless steel, to secure the physical characteristics and surface finish required for the particular war job it is to perform. But one day all the hot and cold rolling, heat treating, and pickling, grinding or polishing is completed, and bright sheets of Allegheny Stainless lie on protective layers of heavy paper, ready for final inspection and shipment to the war plants.

They're *right,* those sheets—flawless of surface and true to desired specifications. Only one essential remains: that they be used as carefully as they were produced—fabricated with an absolute minimum of rejects, spoilage, undue scrap, or waste in any form. ● Call on us for any printed data or personal help.

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books

FOR METALLURGICAL ENGINEERS

Copper and Its Alloys

COPPER AND COPPER BASE ALLOYS. *By R. A. Wilkins and E. S. Bunn. Published by McGraw-Hill Book Co., Inc., New York, 1943. Cloth, 9 x 11¼ in., 355 pages. Price $5.00.*

This new book devotes a chapter to a description and the properties of 11 groups of copper alloys. In each, there is first a brief text designed to give a good general picture of the alloys in the group. Then at least for the more important ones there is a table listing strength and hardness data in addition to certain physical constants. The subject matter in these texts and tables is much the same as is contained in publications of several of the larger copper alloy producers.

The thing which does make this book really outstanding is that the written and tabulated information is amplified by a larger number of useful and informative graphs of mechanical properties than have before been assembled for these (or perhaps most other) alloys. The effect of get-ready and final anneals on tensile strength, yield strength, elastic properties, hardness, grain size, etc. are given for most of the common alloys. Other graphs cover changes in properties resulting from increasing degree of cold rolling or cold drawing reductions over the range ordinarily used in commercial practice. Stress-strain curves for many alloys in several tempers add to the picture.

In addition to the chapters on the individual alloy groups, there are also three chapters on special properties; one on low temperature mechanical properties, another on fatigue and corrosion-fatigue properties, and finally one on bending properties. Although the information contained in these chapters is of considerable practical importance, perhaps the book as a whole would have been more logically arranged if these data had been included in the chapters on the alloy groups along with the other properties there treated.

The authors do not make any statement as to variations from listed properties which might be experienced in commercial practice and it is felt this is a serious omission. While design engineers and specification writers can confidently take the data at face value for average conditions, they should not of course use them as specification minima. A warning that the data are to be considered typical and subject to some variation would not seem amiss, and would not in any way detract from the value of the book.

—D. K. CRAMPTON

Industrial Radiology

INDUSTRIAL RADIOLOGY—SECOND EDITION. *By Ancel St. John and Herbert R. Isenburger. Published by John Wiley & Sons, Inc., New York, 1943. Cloth, 6 x 9¼ in., 298 pages. Price $4.00.*

The second edition of this book is highly interesting and recommended reading for those who, by intent or accident, find themselves put to work in the radiographic department of an industrial plant. It is not, nor is it probably intended to be, a book of advanced thinking in the field of industrial X-rays and gamma rays, but the information put forth should serve as an excellent theoretical foundation upon which most any beginner can erect a framework of practical experience. Moreover, the text should appeal to those other than tyro radiographers, for the material is lucidly presented and contains thoughts of considerable value to many different kinds of engineers in many different types of industries.

Although they do not seriously affect the factual statements, the book undoubtedly has its faults and mistakes, as so many books do. For example, early in the story, the authors set bravely out to discuss the nature of radiation and, in so doing, they slither uncertainly around on the very precipice overhanging the abyss of nuclear physics. Several times it seems the jig is up, but always there is the miraculous recovery, the quick scramble followed by return to an even keel. Much of this dissertation could have been deleted with a resultant clarification of meaning.

Then, too, the scope of the book is nowhere near as huge as the authors would have us believe. In the introduction, they define the term "industrial radiology" as embracing the entire science of X-rays and gamma rays as industrially applied. While maybe 90 percent of such applications have been mentioned, new low voltage X-ray data, new filtration techniques, and ionization possibilities receive but scant attention. It likewise seems incongruous to dig so enthusiastically into nuclear physics, yet almost disregard the more pertinent study of photographic materials, reactions, and processes.

The authors have done a good job with their bibliography, having listed 1314 papers and books on every subject in any way bearing on X-rays or gamma rays. In addition, the latter part of the book is crammed with technique charts, absorption tables, lead protective values, operating cost figures, and a host of other information and suggestions which might benefit newcomers.

A copy of this book should be in every plant using X-ray or gamma ray inspection and its contents should be read by any who are approaching the subject of industrial radiography without a previous knowledge of it. In short, "Industrial Radiology" is adequate.

—ROBERT C. WOODS

How to Use The Microscope

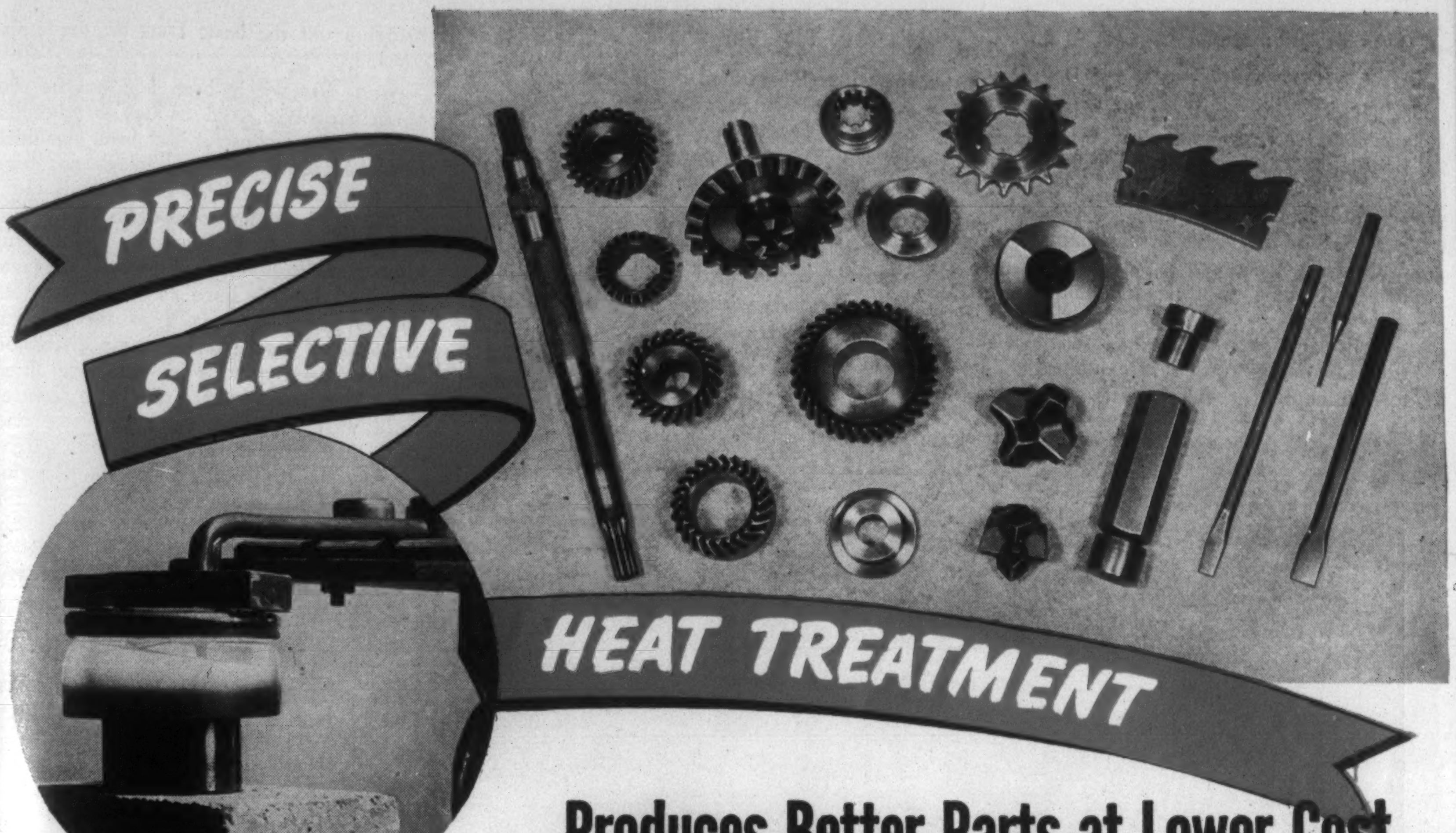
THE MICROSCOPE AND ITS USE. *By Frank F. Munoz and H. A. Charipper. Published by Chemical Publishing Co., Inc., Brooklyn, N. Y., 1943. Cloth, 5¾ x 8¾ in., 334 pages. Price $2.50.*

In their preface the authors state that there is a "definite need for a small, practical guide to the use" of the microscope. "Such a guide should be written in very clear, non-technical language and with suitable illustrations and diagrams where necessary."

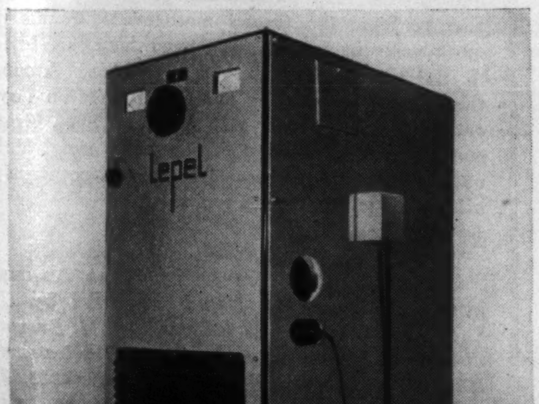
The authors have measured up to the specifications and have produced a brief practical discussion which should appeal to the practical man or student. It is not offered as a scientific treatise but as a guide to aid technicians and students in the use of the instrument.

There are 10 chapters on such subjects as: Evolution of the Microscope, The Modern Microscope, The Microtome, The Use and Care of the Microscope, The Metallurgical Microscope, The Polarizing Microscope, and Accessories. The chapter on the metallurgical microscope will be of interest and value to early students in metallurgical engineering.

(Continued on page 658)



Heat treating the wearing face of a coupling by the Lepel High Frequency Induction Heating Process. Toughness and ductility of the balance of the part is unimpaired.



The heart of precise, selective heat treating, the Lepel High Frequency Induction Unit—compact, easily movable, relatively inexpensive. Operated manually or fully automatic.

Produces Better Parts at Lower Cost...

Precise, selective heat treatment, as developed and perfected by Lepel, permits the application of heat up to any selected temperature, *exactly* where it is required and for the *exact* period of time necessary to produce the desired result.

Amazing in its speed, Lepel equipment reduces from minutes to seconds the time required for hardening, annealing, stress relieving and for brazing and soldering—the same unit performing all of these operations. Yet it maintains a degree of precision and uniformity rarely attainable through other methods.

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Lepel equipment achieves the ultimate in simplicity of operation, dependability and cleanliness. As a result, Lepel installations in many leading war industries are operated entirely by women.

While Lepel equipment has been a boon to wartime production, it is instantly adaptable to peace-time applications without any conversion whatever.

Write or wire for complete information, or, better still, send us samples of your work with specifications for heat treating, brazing or soldering. Our engineers will then perform the work specified and return the samples with specific data, recommendations and cost estimates. This service entails no expense or obligation on your part.

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PIONEERS IN INDUCTION HEATING
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HIGH FREQUENCY INDUCTION UNITS

Book Reviews:

(Continued from page 656)

There is one brief chapter devoted to a discussion of "Common Errors in the Use of the Microscope." A fairly complete glossary of words and terms, as well as a selected bibliography and a complete index add to the value of the book. There are a large number of illustrations furnished by the four leading builders of microscopes.

Only one page is devoted to the electron microscope which is explainable due to the nature of the authors' discussion.

—Edwin F. Cone

Ferrous Metallurgy

Ferrous Production Metallurgy. *By John L. Bray. Published by John Wiley & Sons, Inc., New York, 1942. Cloth, 6¼ x 9¼ in., 457 pages. Price $4.00.*

This is a text book. The topics are old, for all such text books discuss raw materials, refractories, blast furnace operation, converter, open-hearth, and electric melting. The story ends with pig iron, the puddled iron ball ready for the squeezer and the steel ingot; the products are not followed through the rolling mill or the foundry, hence there is space enough for bringing out the basic facts on the topics covered.

Stress has wisely been laid on the economics involved, and enough of the history of the industry has been included to make the dose of technology not hard for a student to take. The style is clear.

The book is up to date in many features, most of the recent developments have some mention, and usually adequate mention, though, since considerable attention is given throughout to the physical chemistry of steel making, some discussion of the Perrin process would have fitted in. The subject of grain size control could well be given more extensive and emphatic treatment, for the student ought to know something about it. The Adirondack ore deposits are mentioned, but their coming importance is not adequately brought out.

On the whole, the treatment is good, the book is both instructive and readable. Not only is it the latest in its field, but one of the best.

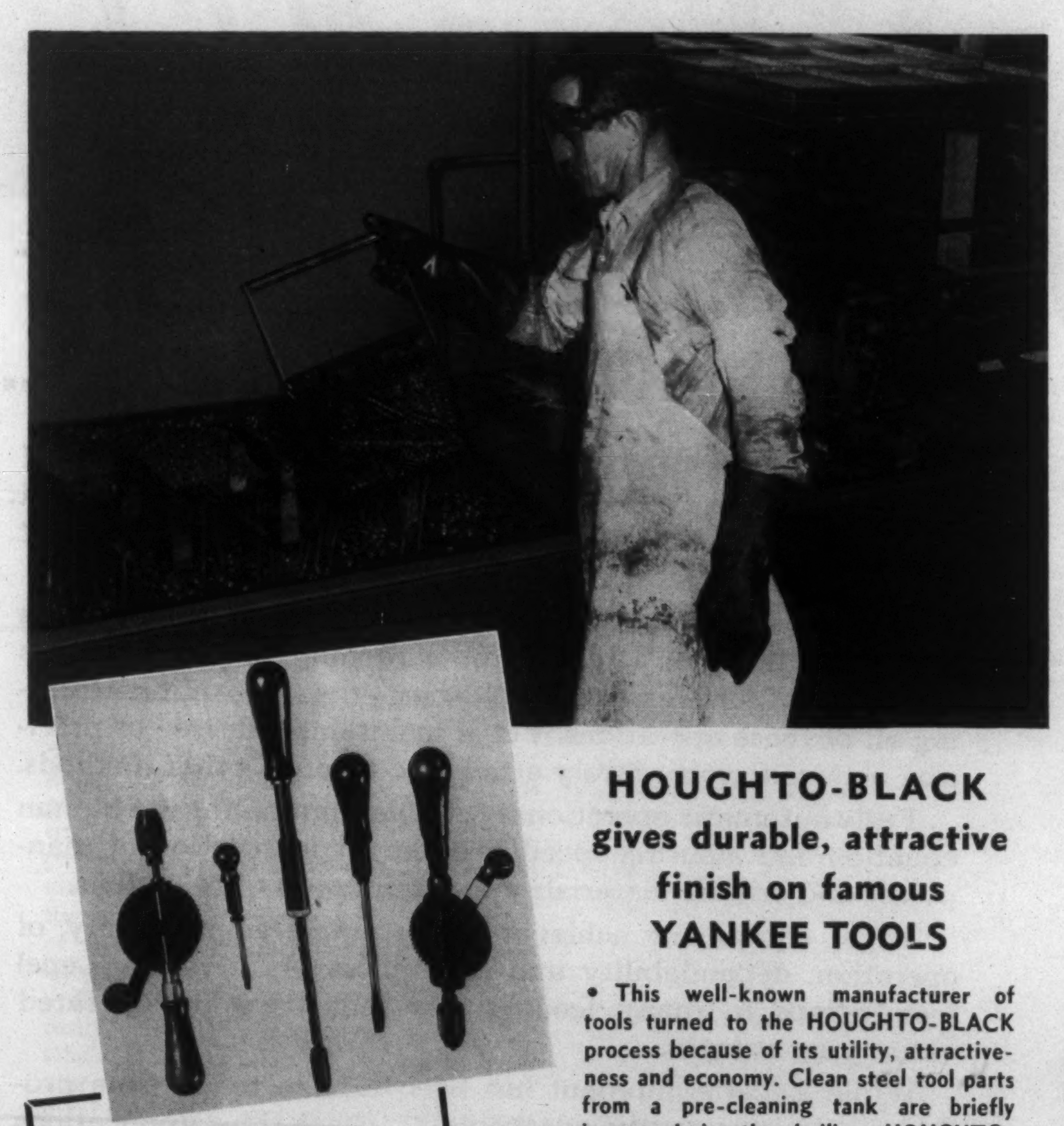
—H. W. Gillett

Other New Books

Mathematics for the Sheet Metal Worker. *Clayton E. Buell. Published by Pitman Publishing Corp., New York, 1943. Cloth, 5½ x 8¾ in., 199 pages. Price $200.* This book is dedicated to the practical shopman. The author has endeavored to present a practical applied mathematics book that will fill the need of workers, both male and female, who wish to advance themselves in the sheet metal and allied trades. An outstanding feature is its departure from the formal mathematics found in most books in favor of problems directly related to the sheet metal and allied trades. Among the 14 chapters may be mentioned those on Layout of Angles, Lines, and Figures; Shop Trigonometry; Measurement of Lengths, Areas, Volume, and Weights; etc. The book is copiously illustrated with line drawings.

Bibliographical Survey of Solid Absorbents. *By Victor R. Deitz. Published by U. S. Cane Refiners Research Project, J. M. Brown, Chairman, Revere Sugar Refinery, Charlestown, Mass., 1943. About 900 pages. Price $12.00.* The scope of adsorption is so various and proliferous that all books on the subject are necessarily confined to special problems. This survey, covering 6,002 contributions to the scientific literature, was planned to enable one to scan, if not the whole field, at least the material overlapping that of some immediate interest. The volume is divided into seven chapters: I. Adsorption of gases and vapors on solid adsorbents; II. Adsorption from solutions on solid adsorbents; III. Thermal effects in adsorption processes; IV. Theories of adsorption; V. Purification of sugar and other applications of adsorbents; VI. General information on adsorbents and special methods of investigation; VII. Preparation of carbon adsorbents. There is a complete author index and a large and useful subject index. A large list of books dealing with the subject of adsorption is appended.

The Asbestos Factbook. *Published by Secretarial Service, Philadelphia, 1942. Paper, 5 x 7½ in., 16 pages. Price 10 cents.* This little pamphlet contains many facts worth knowing about asbestos—its origin, locations, uses, analyses, qualities and so on. It can be used to answer many inquiries about this unusual and interesting non-metallic material.



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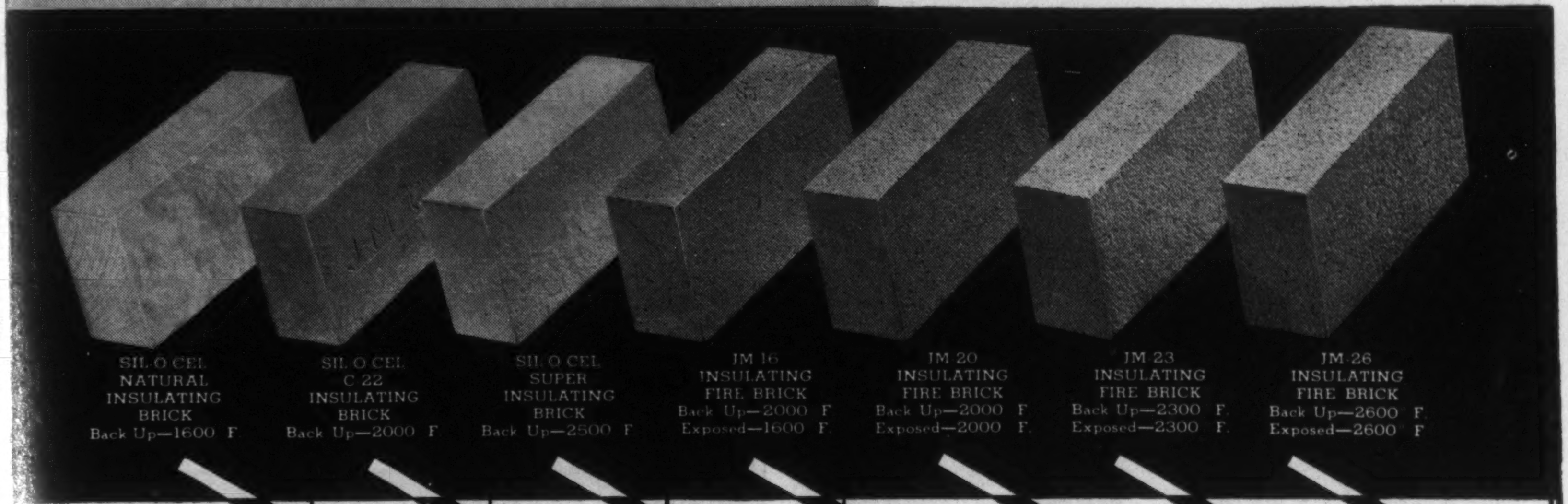
SIL-O-CEL NATURAL INSULATING BRICK Back Up—1600 F
SIL-O-CEL C-22 INSULATING BRICK Back Up—2000 F
SIL-O-CEL SUPER INSULATING BRICK Back Up—2500 F
JM-16 INSULATING FIRE BRICK Back Up—2000 F Exposed—1600 F
JM-20 INSULATING FIRE BRICK Back Up—2000 F Exposed—2000 F
JM-23 INSULATING FIRE BRICK Back Up—2300 F Exposed—2300 F
JM-26 INSULATING FIRE BRICK Back Up—2600 F Exposed—2600 F

Properties	SIL-O-CEL NATURAL INSULATING BRICK	SIL-O-CEL C-22 INSULATING BRICK	SIL-O-CEL SUPER INSULATING BRICK	JM-16 INSULATING FIRE BRICK	JM-20 INSULATING FIRE BRICK	JM-23 INSULATING FIRE BRICK	JM-26 INSULATING FIRE BRICK
Density—lb. per cu. ft.	30	38	40	22	31	38	44
Transverse Strength—lb. per sq. in.	140	115	90	70	100	135	150
Cold Crushing Strength—lb. per sq. in.	400	700	300	70	125	170	165
Linear Shrinkage—%	1.4 @ 1600° F	0.8 @ 2000° F	2.0 @ 2500° F	0.0 @ 2000° F	0.0 @ 2000° F	0.0 @ 2300° F	0.5 @ 2600° F
Reversible Thermal Expansion—Percent	0.1 @ 1600° F	0.7 @ 2000° F	1.29 @ 2000° F	0.5—0.6 @ 2000° F	0.5—0.6 @ 2000° F	0.5—0.6 @ 2000° F	0.5—0.6 @ 2000° F
Conductivity at Mean Temperature	‖ ⊥						
500° F	1.01 .67	1.67	1.70	.75	1.01	1.26	1.61
1000° F	1.13 .79	1.88	1.95	1.01	1.19	1.49	1.90
1500° F	1.24 .90	2.08	2.19	1.41	1.49	2.05	2.61
2000° F	... ..	...	2.45	...	1.91	3.37	4.29
Recommended Service							
Back Up	1600° F	2000° F	2500° F	2000° F	2000° F	2300° F	2600° F
Exposed	....	....	....	1600° F	2000° F	2300° F	2600° F
Recommended Mortar for Setting Brick	Sil-O-Cel Mortar	Sil-O-Cel Mortar	Sil-O-Cel Super Brick Mortar	J-M No. 1626 Cement	J-M No. 1626 Cement	J-M No. 1626 Cement	J-M No. 1626 Cement

Note:—1. Above tests are in accordance with ASTM tentative standards.
2. Conductivity is expressed in Btu. in. per hr. per sq. ft. deg. F. at the designated mean temperatures.
3. ‖—with heat flow parallel to brick strata.
⊥—with heat flow perpendicular to brick strata.

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PERMOPIVOTS are tipped with a special alloy which has the following exceptional qualities:

- ☑ **WEAR RESISTANT...** The Permometal tip gives precision instruments longer life and greater accuracy under actual operating conditions.
- ☑ **NON-CORROSIVE...** Permopivots cannot rust or corrode.
- ☑ **NON-ABRASIVE...** The satin-smooth tip eliminates abrading particles of wear.
- ☑ **ELIMINATES OIL...** It is often possible to eliminate oil because of the extremely low coefficient of friction with Permopivots.

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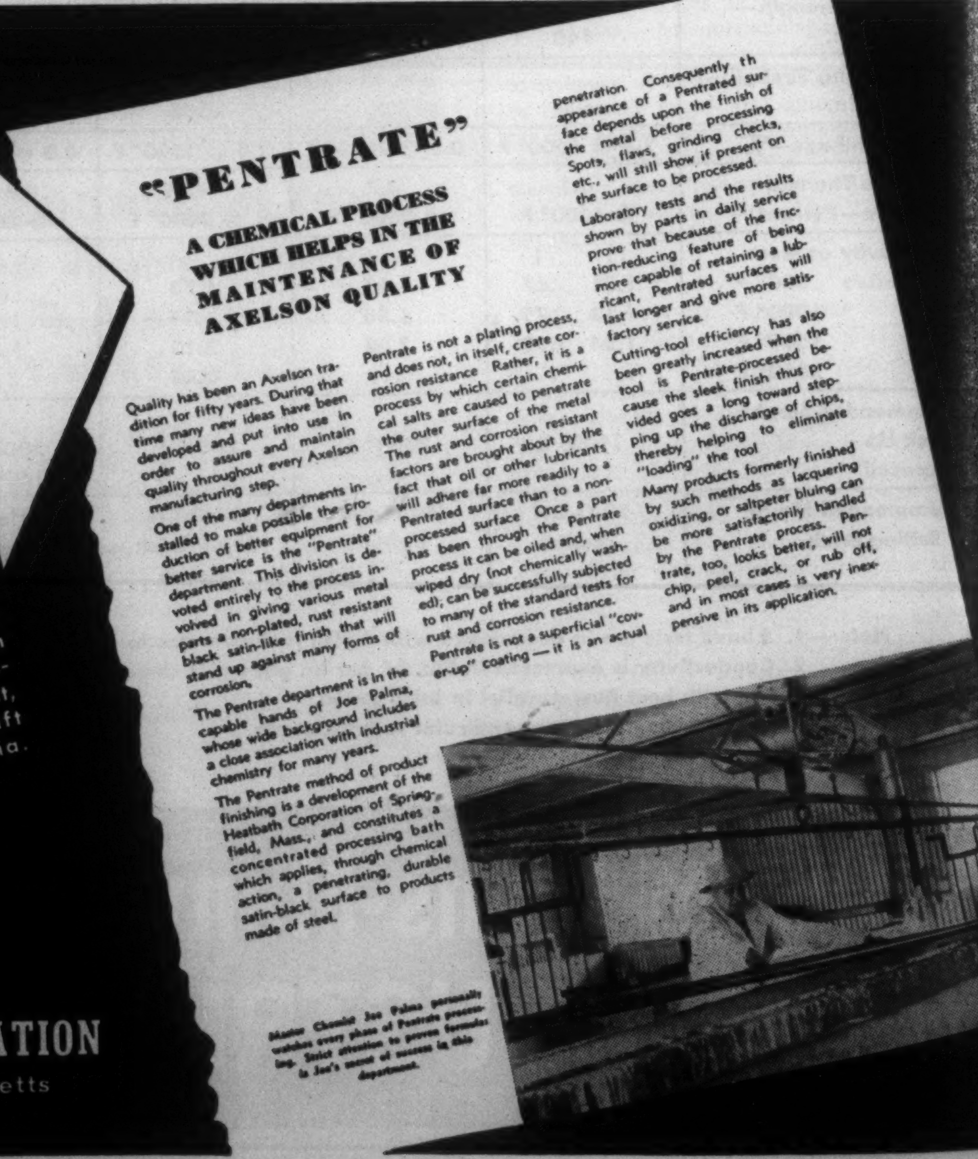

"PENTRATE"

A CHEMICAL PROCESS WHICH HELPS IN THE MAINTENANCE OF AXELSON QUALITY

Quality has been an Axelson tradition for fifty years. During that time many new ideas have been developed and put into use in order to assure and maintain quality throughout every Axelson manufacturing step.

One of the many departments installed to make possible the production of better equipment for better service is the "Pentrate" department. This division is devoted entirely to the process involved in giving various metal parts a non-plated, rust resistant black satin-like finish that will stand up against many forms of corrosion.

The Pentrate department is in the capable hands of Joe Palma, whose wide background includes a close association with industrial chemistry for many years.

The Pentrate method of product finishing is a development of the Heatbath Corporation of Springfield, Mass., and constitutes a concentrated processing bath which applies, through chemical action, a penetrating, durable satin-black surface to products made of steel.

Pentrate is not a plating process, and does not, in itself, create corrosion resistance. Rather, it is a process by which certain chemical salts are caused to penetrate the outer surface of the metal. The rust and corrosion resistant factors are brought about by the fact that oil or other lubricants will adhere far more readily to a Pentrated surface than to a non-processed surface. Once a part has been through the Pentrate process it can be oiled and, when wiped dry (not chemically washed), can be successfully subjected to many of the standard tests for rust and corrosion resistance.

Pentrate is not a superficial "cover-up" coating — it is an actual penetration. Consequently the appearance of a Pentrated surface depends upon the finish of the metal before processing. Spots, flaws, grinding checks, etc., will still show if present on the surface to be processed.

Laboratory tests and the results shown by parts in daily service prove that because of the friction-reducing feature of being more capable of retaining a lubricant, Pentrated surfaces will last longer and give more satisfactory service.

Cutting-tool efficiency has also been greatly increased when the tool is Pentrate-processed because the sleek finish thus provided goes a long toward stepping up the discharge of chips, thereby helping to eliminate "loading" the tool.

Many products formerly finished by such methods as lacquering, oxidizing, or saltpeter bluing can be more satisfactorily handled by the Pentrate process. Pentrate, too, looks better, will not chip, peel, crack, or rub off, and in most cases is very inexpensive in its application.

Master Chemist Joe Palma personally watches every phase of Pentrate processing. Strict attention to proven formulas is Joe's secret of success in this department.

Excerpt from a recent issue of Axelson CONTACT, published by Axelson Manufacturing Company, pioneer producer of oil well pumping equipment, engine lathes, gages, and aircraft parts, of Los Angeles, California.

Send for free copy of the new Pentrate book

HEATBATH CORPORATION
Springfield, Massachusetts

LATROBE Double-Six

"You will recall the dovetail cutter job in which the tools lasted anywhere from five minutes to one-half hour, and the tools were not cracking but literally exploding. Well, we recently switched to Double-Six with great success. The first tool we tried made of Double-Six was used to machine several hundred pieces, and was in operation about one hundred hours. This was done on N.E. 8620 steel of a hardness of approximately 190 BHN.

The remarkable thing to the foreman of the milling machine department and the boys in the tool crib was that the tool was returned to the crib at the finish of the job and did not require grinding.

In fact, from what I have been told, the tool was cutting better at the finish than it was at the start."

definitely increases tool life... decreases set-up costs...

Ask for a copy of LESCO REFERENCE TABLES, containing page after page of useful technical data and tables. FREE

THE above excerpt is from a letter recently received from an enthusiastic user of Latrobe DOUBLE-SIX. Such performance is typical of Double-Six. Not only will it be found to effect substantial savings in production time, but it will prove superior in many difficult cutting operations. Double-Six can be readily heat-treated to attain maximum efficiency.

Ask for special bulletin on Double-Six.

TOOL STEELS LESCO FOR VICTORY

Latrobe ELECTRIC STEEL COMPANY

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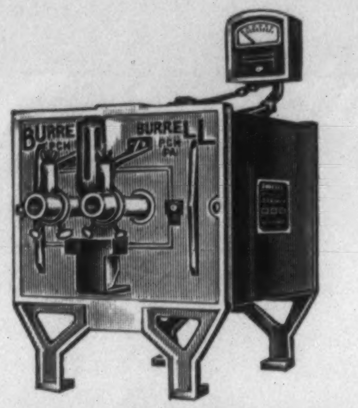
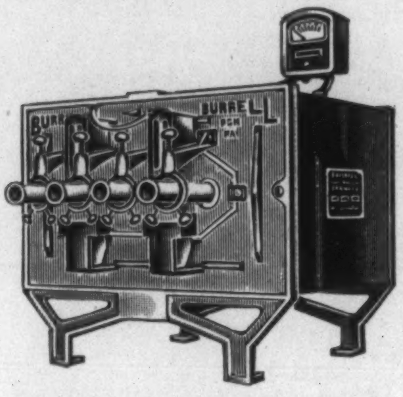
SPECIFICATIONS *Can Be* MET



A24-940 doubles capacity and is the most popular model.



A24-950 with four tubes enables one man to run 125 "carbons" in 8 hours.

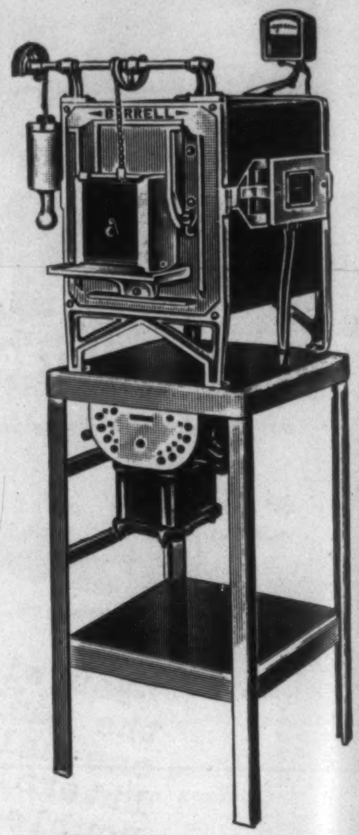
BURRELL *High Temp.* FURNACES—War specifications have demonstrated the value of higher temperatures in fast "clean" determinations of carbon and sulfur in iron and steel analyses. Accelerators are not required.

MULTIPLE TUBE FURNACES—The 2-tube "most popular" model doubles capacity, measures 14"x17"x22" long, has a 9" heating chamber, and consumes 1.5 kw at 2500°F. Top temperatures of 2650°F. are easily maintained.

MODERN ACCESSORIES—Tap transformers modernize and simplify heat control. Pyrometers with rare metal thermocouples continuously indicate operating temperatures.

QUICK ELEMENT CHANGE—The non-metallic heating elements (no nickel or chromium) are silicon carbide rods which can be changed conveniently without dismantling the furnace.

CATALOG F-241—See the new box, muffle, tube, and pit type furnaces which provide convenient working chambers for a wide variety of heating operations in laboratories and pilot plants. Special high temperature furnaces are built to order.



A37-440 Burrell Box Type K Furnaces have been found convenient for all manner of heating operations in laboratories and pilot plants.

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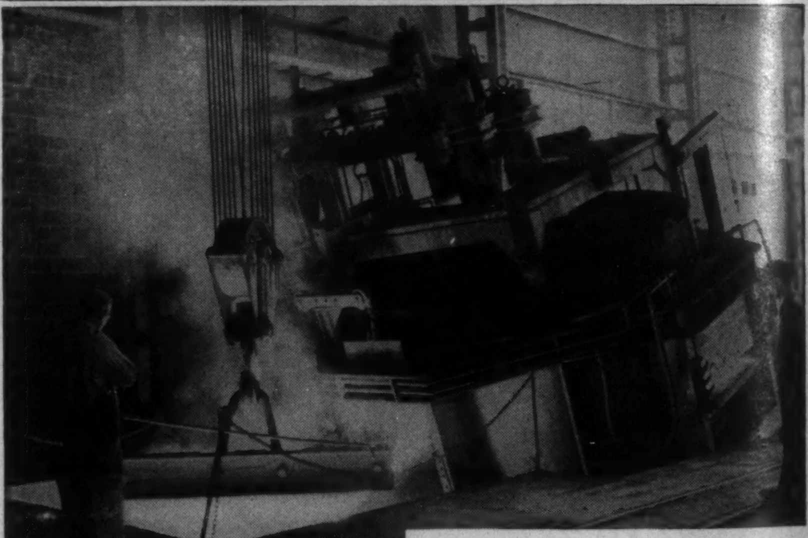

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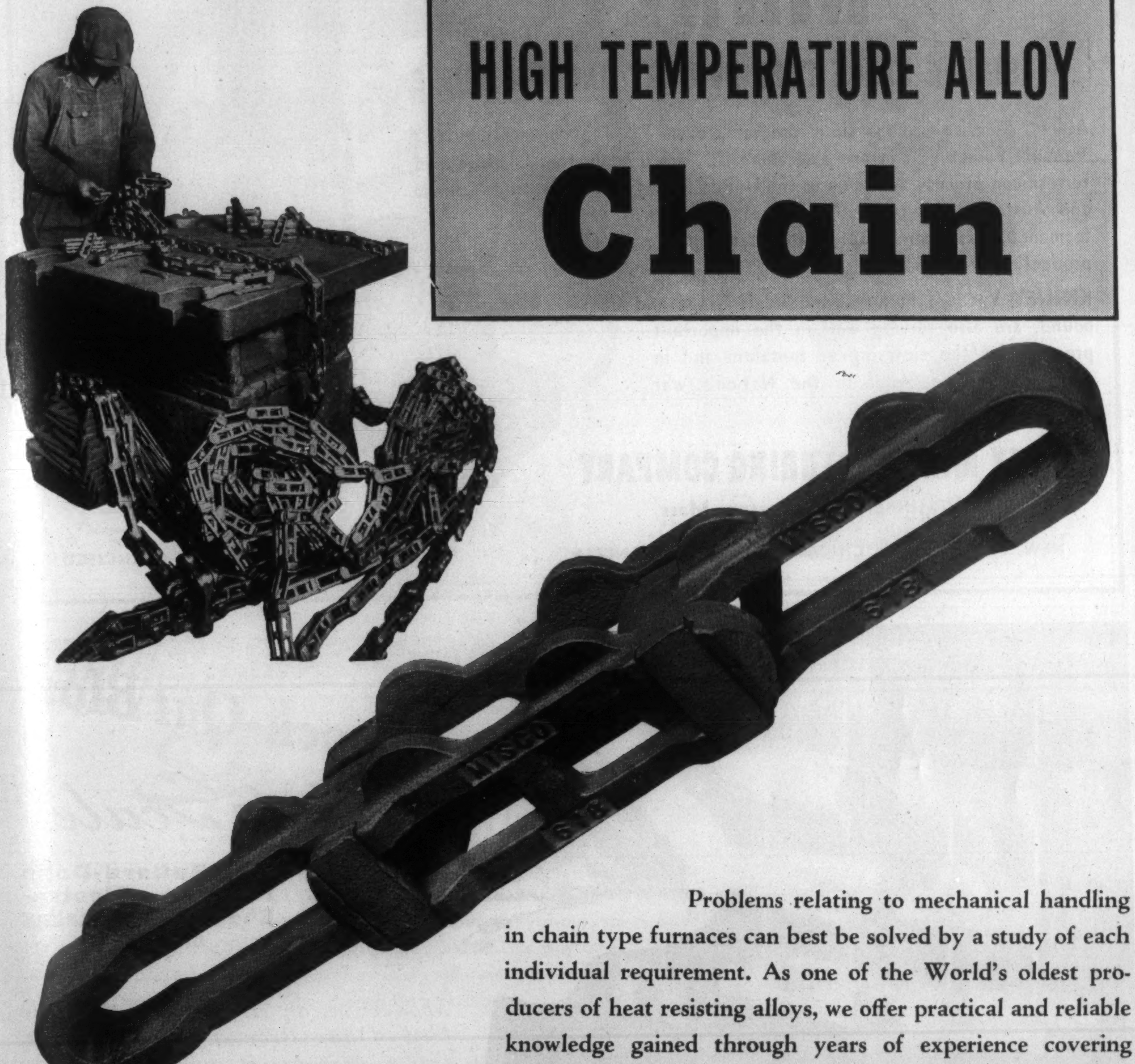

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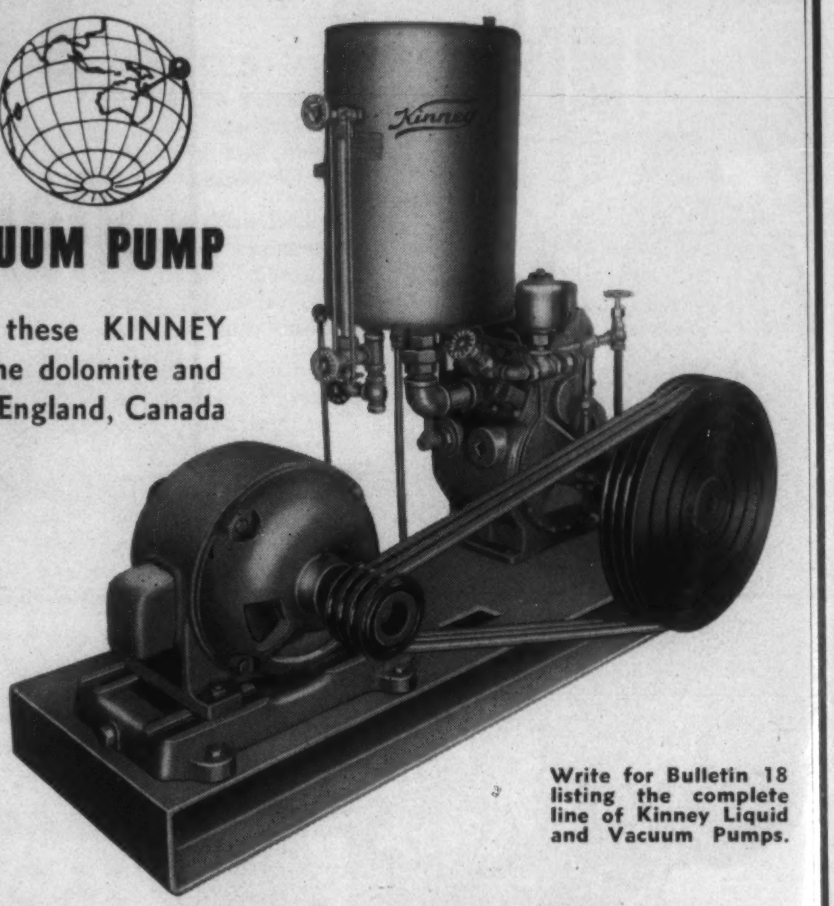
Aiding America's magnesium program, over 1,000 of these KINNEY Vacuum Pumps . . . in one size alone . . . are used in the dolomite and ferrosilicon process. Not only in the United States, but in England, Canada and Australia, this pump, because of its efficient performance, has been adopted for standard use in the production of magnesium.

KINNEY Vacuum Pumps, both Single Stage and Compound, are also serving well in the important program for the sintering of tantalum and in many other fields vital to the Nation's war effort.



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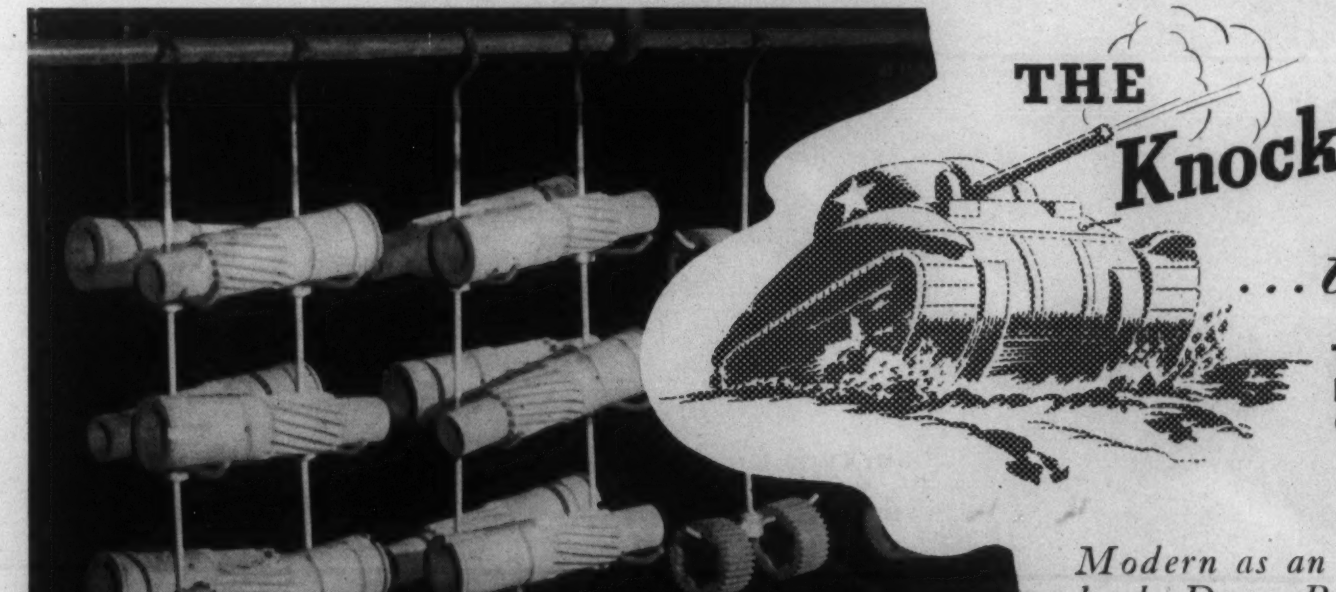

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. . . to Scale

The Bullard-Dunn Process Electro-Chemical Descaling of Metals

Modern as an Army tank, the Bullard-Dunn Process removes scale faster, removes it more thoroughly than any other method. Now, when time is precious as never before, you'll value the savings it makes. No openings too tiny for this electro-chemical process to penetrate. And parts come out chemically clean . . . ready for plating. Send us your data; if possible, send samples.

Note These Advantages

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Each unit in a dust or fume control system must be the *right* unit for the particular kind and condition of dust and air present. Selection of the correct, most efficient units—wet, dry, or centrifugal— from the various makes available, is too important for mere hit-or-miss judgment. Like any other complex mechanical project, the planning of a really efficient dust and fume control system is decidedly a job for *engineering specialists.*

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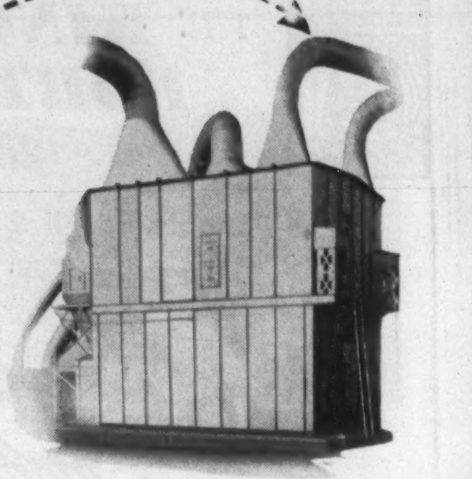
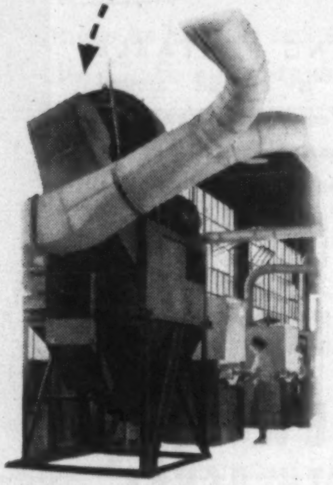
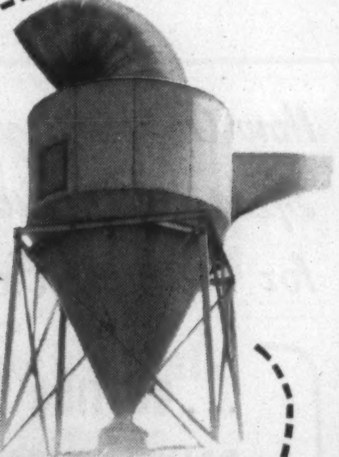
Don't risk serious loss of time and money. Don't let guesswork leave you "stuck" with units that are not right for your particular job. Get the unbiased counsel and planning of experts—Kirk & Blum Engineers. For details write THE KIRK & BLUM MANUFACTURING CO., **2852** Spring Grove Avenue, Cincinnati, Ohio.



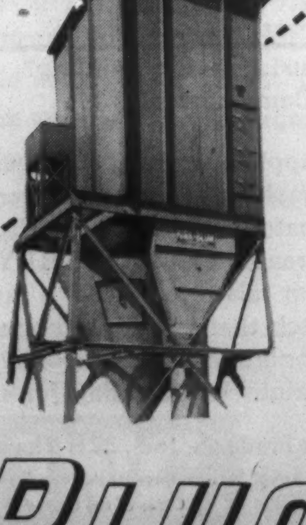
Dry products and clean air required; cloth filter selected



Wet process air cleaning using ROTOCLONE



Centrifugal separator suitable for heavy dust concentration



Combination of centrifugal separator and dry filter.

Other equipment designed and installed by Kirk & Blum . . .
"Cooling Systems for the Glass Industry"
"Industrial Ovens"

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AN ORGANIZATION OF ENGINEERS AND MECHANICS

THE **KING PORTABLE BRINELL**

The Portable Brinell that puts a load of

3000 KG.
on a
10mm. Ball

—required to make a REAL BRINELL HARDNESS TEST.—

The KING PORTABLE BRINELL is an all around Brinell Tester, stationary as well as portable. Its PORTABILITY makes it indispensable for large parts and for saving time.

Throat 4" deep
Gap 10" high — Wt. 26 lb.

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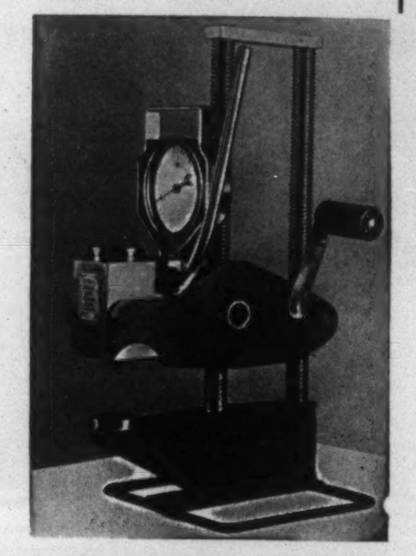

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For: Lead, Salt, Cyanide Oil Tempering, Metal Melting

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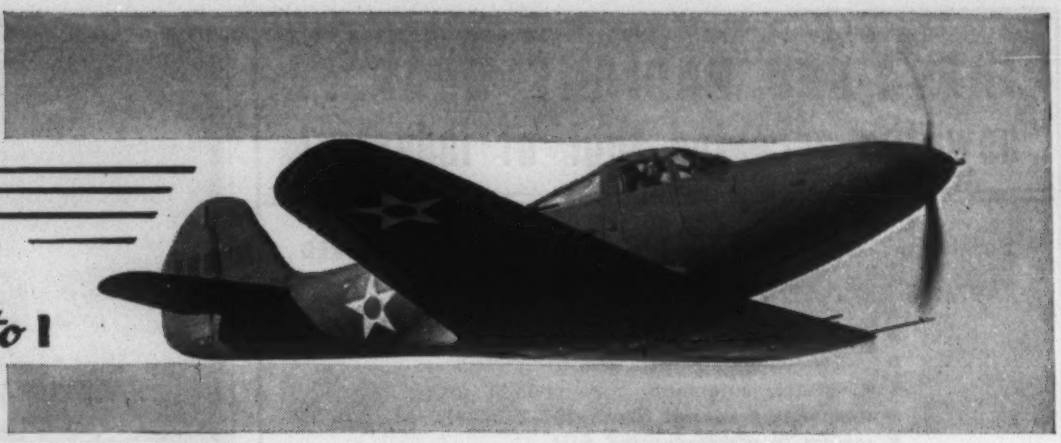

THE combat score continues to run heavily in favor of American fighters on every front.

In the air, the ratio of wins over losses ranges as high as ten-to-one with the "flying fortresses." On land, the U. S. super-tanks are crushing the toughest axis opposition, while the new U. S. tank-busters are breaking up desperate panzer attacks. At sea, too, the latest reports of U-boat sinkings indicate that "a sub a day keeps the Nazis away from American shores."

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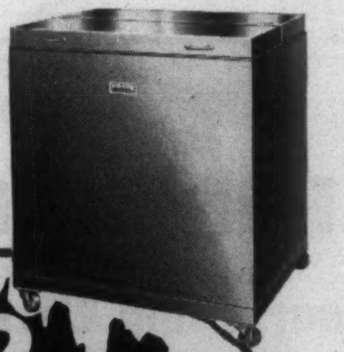

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- ✓ Determine hardness of plating or other thin coatings.
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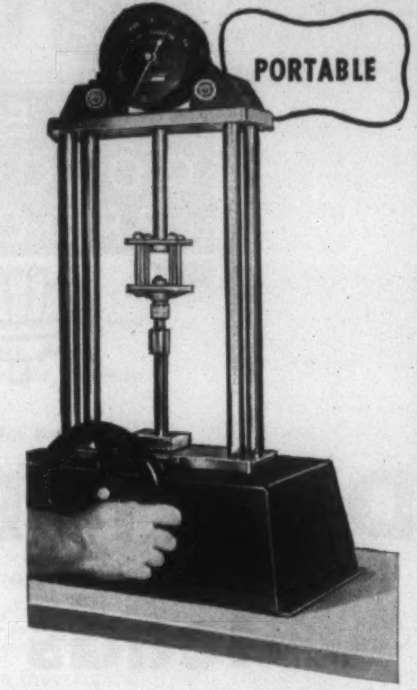

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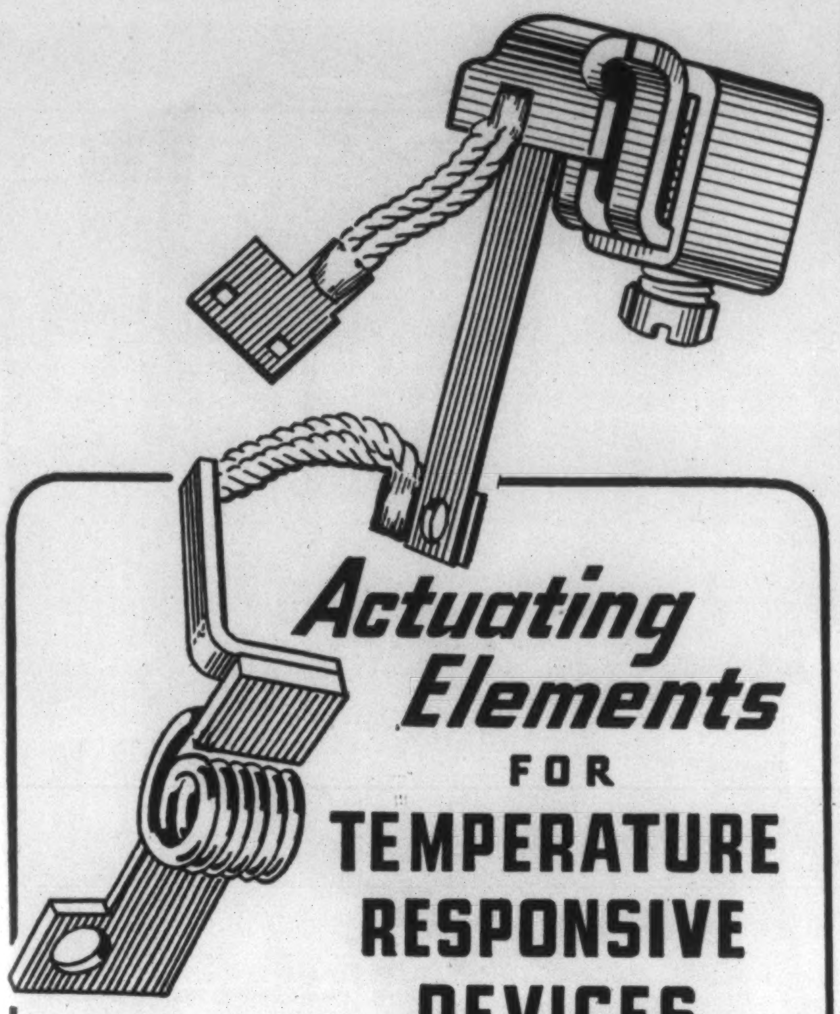

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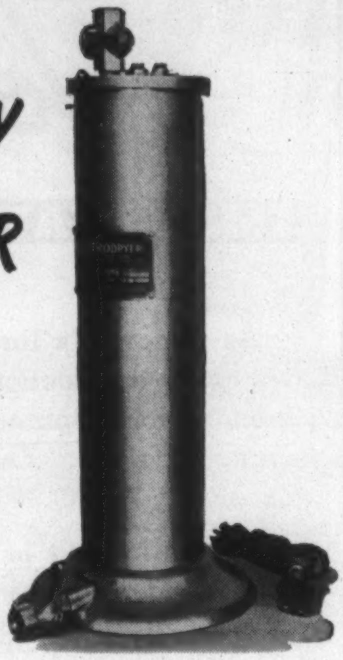

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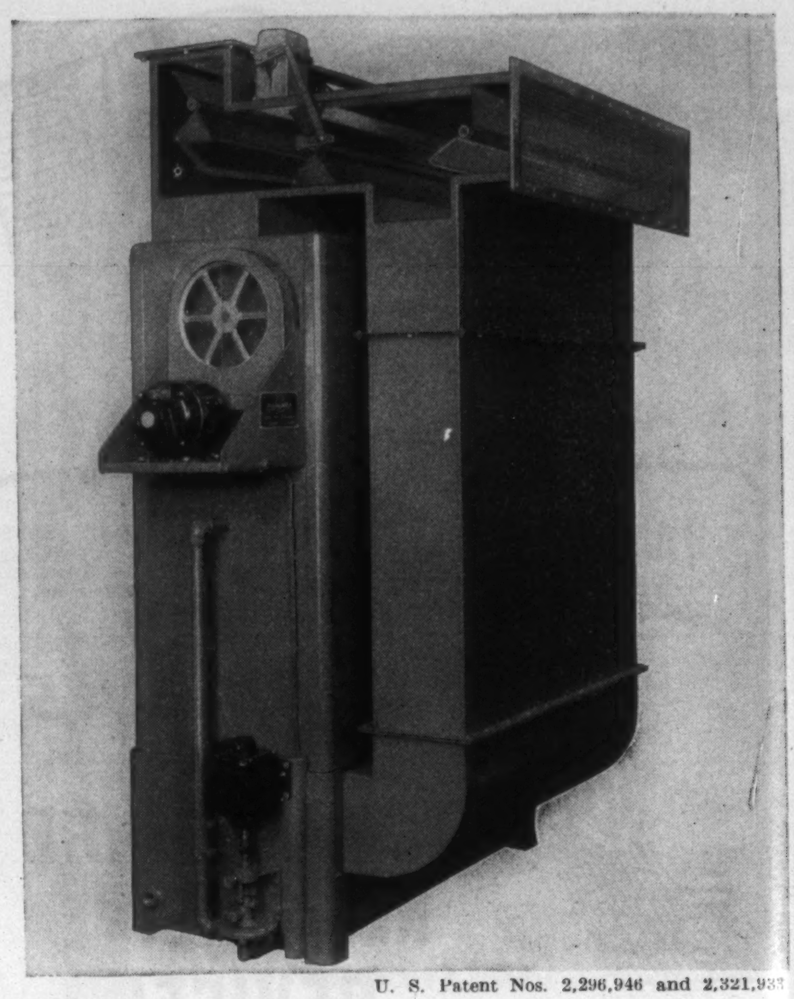

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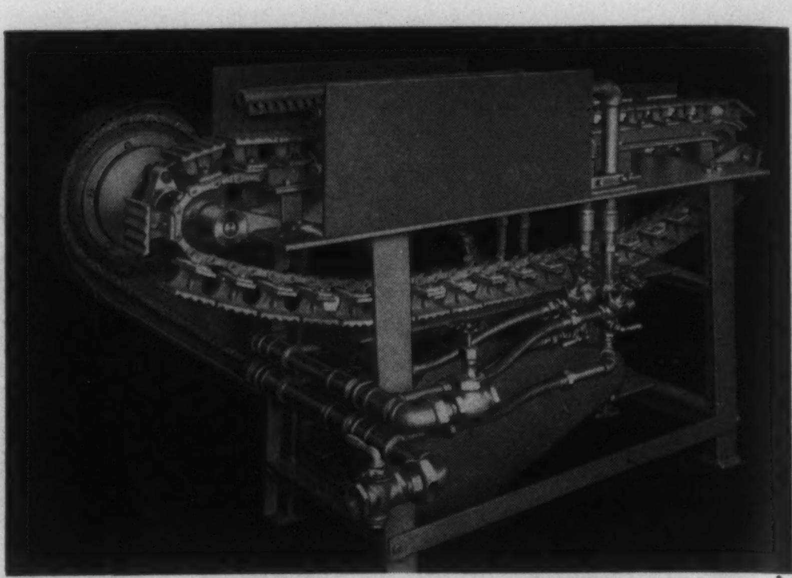

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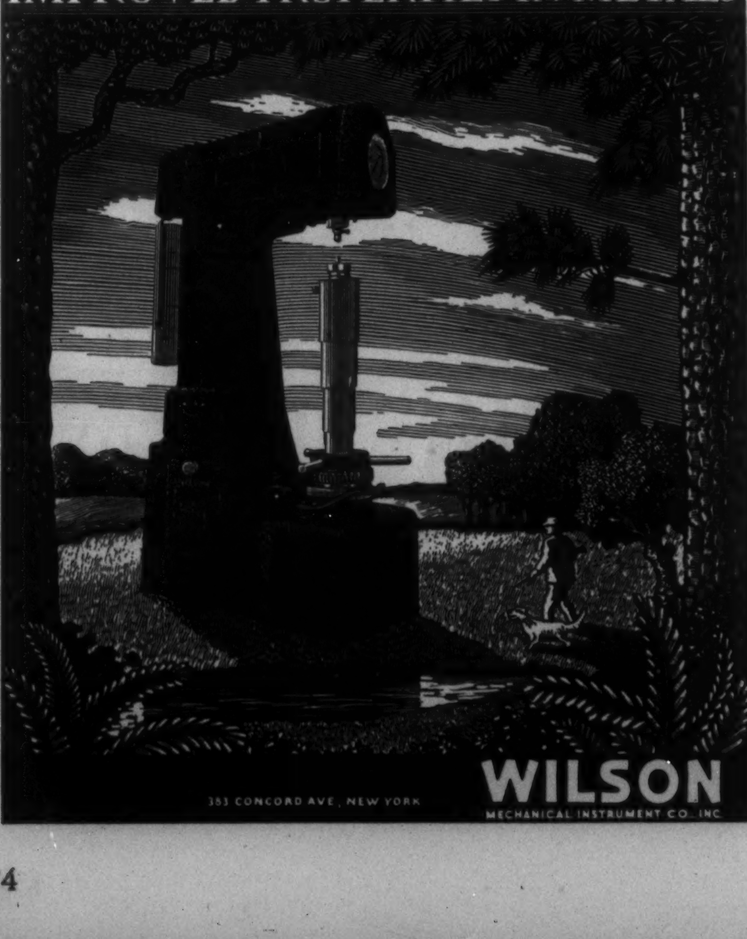

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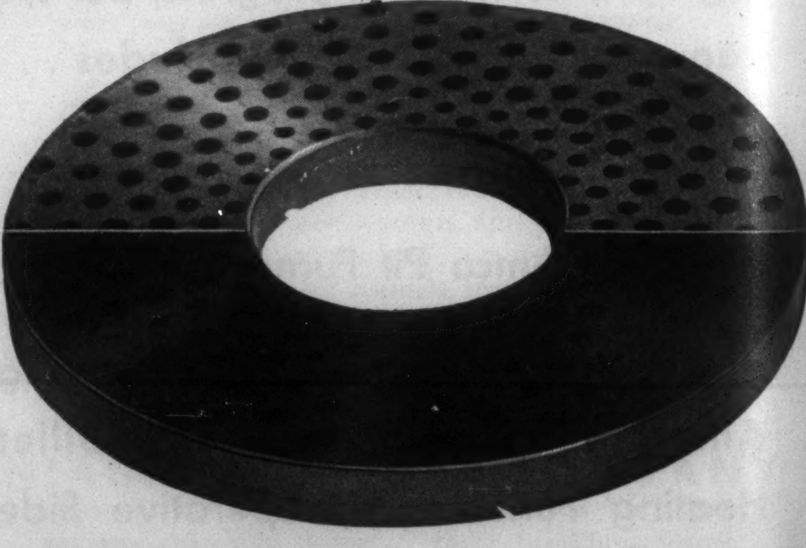

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Non-inflammable, positively no fire hazard.

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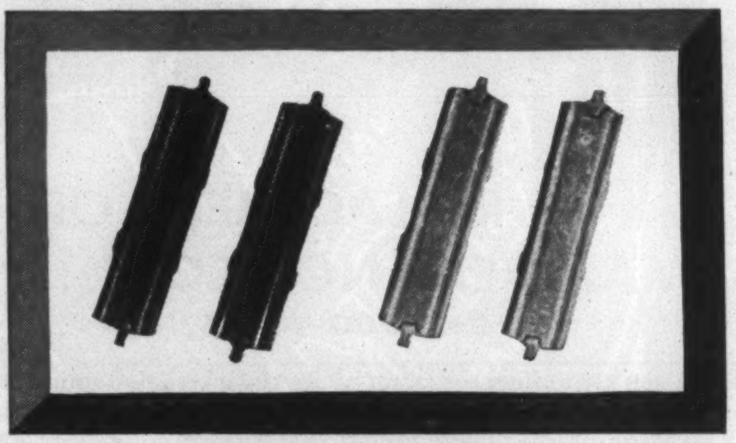

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trends

By Edwin F. Cone

A Steel Ingot Record

Another new record in steel output has been hung up — the total steel ingot and casting production for the first half of 1943 at 43,866,912 net tons is the largest for that period ever reached. And this in spite of a decline in the June output due to the stoppage in coal mining. The record for the first half of this year also exceeded the total for the last half of 1942, establishing a record for any half year period.

More Pig Iron From Fewer Furnaces

In the past three decades the capacity of American blast furnaces has radically increased as evidenced by these data: In 1942 there were 242 blast furnaces with a record breaking capacity of about 64,000,000 net tons. Thirty years ago, or in 1913, there were almost twice as many but their capacity was only about 48,500,000 tons. Modern stacks are larger and better than they used to be but there are fewer of them.

Only Women Employees

The first aviation plant in the United States, making precision aircraft engine and propeller parts, to use women 100 per cent in production operations is the Northern Aircraft Products Div. of the Aviation Corp. in Toledo, Ohio. This policy has proved so successful that men are employed solely as job-setters, supervisors and instructors.

Too Many Machine Tools

We hear and read various opinions about the trends in the machine tool industry, particularly after the war. The following statement credited to the Federal Reserve Bank of Chicago is not cheerful: "The U. S. Government alone reportedly owns machine tools equivalent to 10 yrs.' normal output of the industry. Some estimates indicate that the machine industry has satiated its principal markets for perhaps a quarter of a century or at least until 1960."

Future of the NE Steels

"The advent of the National Emergency Steels with their multiplicity of alloying elements and their generally lean alloy content has pushed ahead by several years the frontiers of both metallurgy and engineering design," said Charles M. Parker, secretary, General Technical Committee of the American Iron and Steel Institute, in an address before a local chapter of the A.S.M. "Under the pressure of war, industry has had to do in a few months development work which normally would have taken a generation." Mr. Parker is reported as refuting the idea that the "NE steels" are of passing importance and as believing that they will undoubtedly live beyond the present emergency.

Expansion in Steel Capacity

The Government's steel expansion program will be virtually completed by the end of 1943, says a recent statement of W.P.B. At that time the nation will have nearly 7,000,000 tons of additional open-hearth capacity; 2,400,000 tons of additional electric furnace capacity; 11,000,000 tons of new blast furnace capacity, and about 7,500,000 tons of added coke oven capacity, as compared with capacities just prior to Pearl Harbor.

Steel Capacity

Our steel capacity is increasing constantly, according to a statement of WPB. Right now (June) our steel making capacity is approximately 91,000,000 net tons a year. By next year the capacity is estimated at more than 97,000,000 tons of steel ingots and castings.

Jewels in the War Effort

It would be pretty difficult to fight a modern battle without a set of jewels—especially if synthetic rubies and sapphires were lacking. The instrument panel of a bomber, says the *Aluminum News Letter,* contains about 100 jewel bearings and a battleship requires well over 5000. Bombsights, electronic controls, range finders, and many other military devices need jewels as well as do watches. Rubies and sapphires, as produced by nature are single crystals of aluminum oxide, the color being due to impurities—the synthetic stones have the same chemical composition.

Automobiles for Scrap

At least 4,000,000 automobiles, trucks, etc. are headed for the scrap pile this year, says an official of the O.P.A. This is an increase over the normal annual rate of 3,000,000. He warned that the nation is rapidly approaching a critical transportation situation. His estimate is that the minimum number of automobiles needed for the war effort is 21,000,000 and said that the country will be close to that dangerous minimum by the first of next year. One advantage of this development is an increase in scrap.

Ilmenite Ore for Fluorspar

Because of the dwindling supply of fluorspar some steel companies are using a low grade ilmenite ore as a substitute in their steel-making operations. Testimony from a reliable source is to the effect that one large steel company is using the ore as a pound for pound substitute for fluorspar. Another plant indicates that about 25 per cent of the ilmenite ore is needed to produce the same effect as fluorspar.